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An Assessment of the
United States Food and Agricultural Research System

Volume II—Commissioned Papers

Part A: Management of Food and Agricultural Research

- I. Agricultural Research Classification for Management Purposes
- II. Effect of Organization, Policy and Procedures on Research Management
- III. Incentives and Disincentives Important to Research Management and Administration

Part B: Determination of Food and Agricultural Research Priorities

- I. Priority Setting Processes in the State Agricultural Experiment Stations
- II. Forces Affecting Food and Agricultural Research Decisions
- III. The Roles of the Joint Council on Food and Agricultural Sciences and the National Agricultural Research and Extension Users Advisory Board in Coordinating Research and Determining Research Priorities
- IV. The Process of Setting Priorities for Food and Agricultural Research

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CONGRESS OF THE UNITED STATES
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Preface

This volume contains papers written for OTA to assist in preparation of the report *An Assessment of the United States Food and Agricultural Research System.* OTA does not endorse these papers. In several instances, the OTA report reaches somewhat different conclusions because of additional information which was obtained later. These papers, however, may prove valuable for readers needing more detailed or specific information than could be accommodated in the final assessment report, and are being made available for such purposes.

Commissioned Papers for

An Assessment of the United States Food and Agricultural Research System

Part A: Management of Food and Agricultural Research

I. Agricultural Research Classification for Management Purposes--William P. Flatt, Hugo O. Graumann, and Arthur W. Cooper

II. Effect of Organization, Policy, and Procedures on Research Management--Roy L. Lovvorn

III. Incentives and Disincentives Important to Research Management and Administration--Thomas S. Ronningen and Hugo O. Graumann

Commissioned Paper I

AGRICULTURAL RESEARCH CLASSIFICATION FOR MANAGEMENT PURPOSES

William P. Flatt, Hugo O. Graumann, and Arthur W. Cooper

Office of Technology Assessment

October 15, 1980

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GLOSSARY

AID	Agency for International Development in the State Department
AMS	Agricultural Marketing Service of the USDA
APHIS	Animal Plant Health Inspection Service
AR	Agricultural Research
ARPAC	Agricultural Research Policy Advisory Committee
ARS	Agricultural Research Service, USDA (now SEA/AR, Science and Education Administration Agricultural Research)
ASCUFRO	Association of State College and University Forestry Research Organization
BAE	Bureau of Agricultural Economics
BARC	Beltsville Agricultural Research Center
BARD	Binational Agricultural Research and Development Board, established in 1977 between Israel and the U.S.
CARET	Committee on Agricultural Research, Extension, and Teaching
CAST	Council for Agricultural Science and Technology
CGIAR	Consultative Group on International Agricultural Research
CR	Cooperative Research
CRIS	Current Research Information System, USDA (organized for automatic data processing of information on State Agricultural Experiment Stations and USDA research projects)
CSRS	Cooperative State Research Service (now SEA/CR)
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DU	Decision Units used by SEA to prepare Zero Base Budget
ECOP	Extension Committee on Organization and Policy
EMIS	Extension Management Information System
EPA	Environmental Protection Agency
ERS	Economic Research Service
ES	Extension Service
ESCOP	Experiment Station Committee on Organization and Policy
ESCS	Economics, Statistics, and Cooperatives Service
FAO	Food and Agriculture Organization of the United Nations
FAS	Foreign Agricultural Service, USDA
FDA	Food and Drug Administration of the Department of Health and Welfare
FGIS	Federal Grain Inspection Service
FIFRA	Federal Insecticide/Fungicide/Rodenticide Act
FS	Forest Service
FSQS	Food Safety and Quality Service of the USDA
GSA	Government Services Agency
HEW	Health, Education and Welfare Department (now Department of Health and Human Resources)
HHR	Department of Health and Human Resources
IDU	Internal Decision Units
IPA	Intergovernmental Personnel Act
JPE	Joint Planning and Evaluation
MAPS	Management and Planning System used by SEA/AR
MIS	Management Information System
NASULGC	National Association of State Universities and Land-Grant Colleges
NPC	National Planning Committee
NPS	National Program Staff of SEA
NRP	National Research Programs
NRPC	National Research Planning Committee
NSF	National Science Foundation
OICD	Organization for International Cooperation and Development of the USDA
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy of the President
OT	Office of Transportation of the USDA
OTA	Office of Technology Assessment, Congress of the United States
PARIS	Program Analysis Research Information System

PASA	Participating Agency Service Agreement
PHT	Post-Harvest Technology
PL 480	Public Law 480 providing funds for research
PPS	Program Planning Staff of SEA
PRW	Program Reviews and Workshops by USDA SEA/AR
RICOP	Resident Instruction Committee on Organization and Policy
RL	Research Leaders
RP	Research Program
RPA	Research Problem Area
RPC	Regional Planning Committee
RPG	Research Program Group in the CRIS system of classification
RRPC	Regional Research Planning Committee
RUG	Research Users Group
SAES	State Agricultural Experiment Stations
SCS	Soil Conservation Service
SEA	Science and Education Administration
SEA/AR	Science and Education Administration Agricultural Research
SEA/CR	Science and Education Administration Cooperative Research
SRP	Special Research Programs
SRPC	Southern Research Planning Committee
SSIE	Smithsonian Science Information Exchange
SY	Scientific-Person Years. In SAES it is a research scientist with a rating of Assistant Professor or higher. In the USDA it is a GS-11 or higher, excluding both administrators
TDY	Temporary Duty
UNDP	United Nations Development Program
WRU	Work Reporting Units
ZBB	Zero Base Budgeting

I. SUMMARY

The agricultural research system in the United States has evolved as a decentralized, interlocking, complementary federal/state partnership capable of responding to local, state, regional, national and international needs. In addition to this pluralistic, publicly supported research effort, the private sector conducts and sponsors agricultural research. The success of this system of agricultural research management is evident, and numerous studies have shown that the public has benefitted greatly from investments in agricultural research. The past investments have returned about 50 percent per annum, and estimates of future internal rates of return are of the same magnitude.

Management is defined as "the judicious use of means to accomplish an end." Research is "investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts or practical application of such new or revised theories or laws" (Webster, 1977).

Agricultural research management involves the systematic allocation and direction of the use of funds, scientists, support personnel and other resources to seek solutions to problems and to explore opportunities related to food and agricultural sciences. Food and agricultural sciences are defined in the broadest sense to include the production, processing, distributing, marketing and utlization of food, fiber and renewable resources. Soil and water conservation, land use, human nutrition and improved quality of life are included in the broad definition.

A successful decentralized management system is dependent upon an effective means of classifying and reporting research problems. A classification system or combination of systems is needed to facilitate communications among scientists, administrators, legislators and the general public. Managers responsible for the allocation and utilization of resources to conduct food and agricultural research usually use one or more classification systems to develop plans and account for how resources were used. Several research classification systems have been developed and used successfully to manage agricultural research in the United States. The most effective systems are CRIS (Current Research Information System) for state and federal agricultural research agencies, and MAPS (Management and Planning System) for the USDA SEA/AR laboratories. Each of the systems has been used effectively in spite of limitations. The advantages and disadvantages of these and other systems are discussed in this paper. The need for exploring the possibility of combining the CRIS and MAPS systems is pointed out.

The federal authorizing legislation responsible for the state/federal partnership and development of research units dating from the establishment of the USDA and land-grant colleges in 1862, to the Hatch Act of 1887, establishing State Agricultural Experiment Stations, and the subsequent legislation through the National Agricultural Research, Extension and Teaching Policy Act of 1977 (PL 95-113 Title XIV) are summarized.

The development of agricultural research in the U.S. evolved from individual, local initiative in the early years of the colonies, to one of state and federally supported state experiment stations in the late 1800's, and then the development of the federal USDA national laboratories early in the 1900's.

Publicly supported research in food, agriculture and forestry is currently conducted primarily by the following agencies or institutions:

56 State Agricultural Experiment Stations (including Departments of Forestry, Schools and Colleges of Veterinary Medicine and Home Economics)

16 Schools of Forestry

16 Land-Grant Colleges established in 1890, and Tuskegee Institute

USDA Federal Research organizations including:

The Science and Education Administration (SEA/AR) at 145 locations
Forest Service (FS)
Economics, Statistics and Cooperatives Service (ESCS)

In addition, private industry supports a considerable amount of agricultural research. International centers and programs are funded from several sources, including private foundations and government agencies.

The criteria for differentiating problems as local, regional, national or international include the geographical extent and scope of the problem, the restrictions on the funds used to support the research, the probable transferability of the results of the research, the primary beneficiaries of results and the regulatory and statutory needs.

Classification of research as local, state, regional, national and international is one means of denoting the unit primarily responsible for sponsoring research. It is one of the means used by legislators in determining whether the USDA federal laboratories (SEA/AR) or the State Agricultural Experiment Stations (SEA/CR) should assume primary responsibility. The mission and goals statement of the USDA Science and Education Administration uses this system of classification to describe the federal, state and private industry relationships. In general, SEA/AR focuses on agricultural problems of broad regional, national and international concerns. State Agricultural Experiment Stations focus on local and regional problems and they work in cooperation with other states and with SEA/AR on national and international research efforts. The food and fiber industry generally performs proprietary applied research and development, but they also contribute to the overall national agricultural research effort. Together, this tripartite system carries out the research necessary to provide a dependable supply of high quality food and fiber to consumers, to develop renewable resources for energy and to maintain a quality environment through sound husbandry of natural resources.

The definitions and examples of state and local, regional, national and international research problems are:

- State and local. Any problem related to agriculture that occurs within a state or portion of a state is defined as a state or local problem. An example is determination of fertilizer and irrigation requirements of crops in various parts of the state.

- Regional. Any problem related to agriculture that extends over a major portion of two or more states within a region or affects the economy, environment or social needs of the major portion of two or more states within a region is defined as a regional research problem. An example is southern corn blight that affects corn in several states in the southern region.

- National. Any researchable problem that extends over a considerable portion of more than one region or has a major impact on the economy, environment or social condition of more than one region is defined as a national research problem. An example is the fall army worm--an insect that overwinters in southern Florida, does some damage there, and also does considerable damage in other states of the southern region and in states of the north central retion.

- International. Research problems which affect the agriculture of two or more countries and can be solved best by the cooperation of the countries affected are defined as international research problems. An example is the problem related to control and eradication of the screw-worm--an ectoparasite of livestock that seriously affects the production of livestock. This insect overwinters n Mexico and, if not controlled, spreads into the United States. It is presently being attacked in Mexico by a joint effort of government agencies in Mexico and the United States.

The major advantage of this system is its simplicity. Broad regional, national and international programs may be identified, and federal funds provided using this system. This simplicity is also a disadvantage in that, for management purposes, it is not specific enough. Problems usually begin as local or state, but if not solved, become regional, national or international. There is also considerable transfer of technology as well as benefits derived from research. Some advantages of classifying research as international are: (1) opportunities for a coordinated thrust on highest priority needs of third world countries; (2) clearer delineation of the kinds and quality of expertise needed to effectively implement planned programs; (3) better planning and coordination of levels of cooperative effort among federal and state agencies; and (4) a clearer understanding of need for an equitable mechanism for shared sustained funding of international programs.

Disadvantages, for management purposes, of differentiating research problems by this means are: (1) many problems fall in the intermediate areas; (2) solutions to problems are conceived by scientists, and often scientists who might not have the problems in their state or spheres of responsibility will have the best ideas for the solution; (3) science knows no geographic boundaries, and therefore it is difficult to limit scientific thought to a classification system; and (4) sometimes having a classification system will stifle creativity. From an international standpoint, the disadvantages would be: (1) competition of time required for participative planning of international programs with that needed to effectively carry out the mandates of primary responsibilities for managing domestic programs; and (2) inability of many domestic agencies to provide continuity of persons to participate in specific third world country programs.

Research planning is a continuous process that encompasses the formal, systematic regional and national agricultural research planning committees of the Joint Council on Food and Agriculture Sciences authorized by Congress, as well as informal, local planning by scientists and research planning groups within states. Individual scientists and teams of scientists use many sources of information, including libraries, computerized information retrieval systems, personal communication, visits with other scientists and other informal means to identify gaps in knowledge and to determine which areas in their disciplines need further investigations. Regardless of how problems are classified for management purposes, scientists use resources allocated to them to solve researchable problems.

The most widely used agricultural research classification system in the United States is the Current Research Information System (CRIS), developed by state and federal agricultural research leaders. It is also used as the basis for preparing state, regional and national research plans.

The regional and national planning committees, which include state, federal and private industry representatives, use the CRIS inventory of agricultural research as the basis for determining the resources currently being allocated to certain commodities or specific categories. With this information, they assess the needs for reallocation of current research and for additional resources needed.

All research is classified by Research Problem Area (RPA), Research Program (RP) and Research Program Group (RPG), as well as by a three-dimensional scheme including: (1) activity, (2) commodity and (3) field of science. There are 98 RPA's arranged in nine generally related groups. A number of special classification categories, such as energy, water resources, pesticides, weather and others are also available for more specific identification of research. This system is described in detail in the Manual of Classification of Agricultural and Forestry Research.

The CRIS system is useful to research scientists and managers in that it provides a means of identifying what research is being conducted, where, by whom and to what extent it is funded. It helps to avoid unnecessary duplication of effort and provides an orderly means of nationwide communication of research planning. It is used particularly by state research leaders in reporting the results of research conducted--whether federal, state or private funds were used.

An example of how research is classified by this method is research on coating cotton for open-end spinning:

Goal V. Improve efficiency in the marketing system.

RPA 501. Improvement of grades and standards - crop and animal products.

Activity 5600. Chemical and physical properties of nonfood products.

Commodity 2100. Cotton

Field of Science 1525. Chemistry - inorganic

The Agricultural Research Service (now SEA/AR) developed a system of classification called Management and Planning System (MAPS). It provides the framework for the supporting systems and information needed for planning, reporting, evaluating, budgeting and executing research. The areas of work are classified into 67 SEA/AR National Research Programs (NRP's) and eight Special Research Programs (SRP's). There are 1400 Work Reporting Units (WRU's) which describe research under one NRP at a given laboratory or work location. Each specific research project within a Work Reporting Unit is reported as a CRIS unit, and there are approximately 3200 of these.

The advantage of this system is that it is simple, flexible and specific enough to be useful in managing a large, widely dispersed regional and national federal research program. It is also compatible with the CRIS system used by the State Agricultural Experiment Stations. People rather than systems and procedures formulate research goals and plans, and develop strategies for their implementation. MAPS provides for a unified, effective program management system which permits the agency to meet the needs of its scientists, agriculture and society. While the work group has no specific recommendation for how to do this, there is merit in examining the rationale for possibly combining CRIS and MAPS into one classification system. The manner in which CRIS units are aggregated for planning purposes, the possibility of increased flexibility to include new research problem categories in the future and a means of obtaining more timely, up-to-date information from this system are among the needed revisions. Some of these features have already been incorporated into a Program Analysis Research Information System (PARIS)--a management system for SEA/AR that is used for current information needs.

Other means of differentiation of research problems for management purposes include basic, applied or development, location-specific, such as by soil type, unique climate, pest problems, specific contaminants, scope and magnitude of work, output destination and political stratifications. Special classification systems which are essentially further refinements of the CRIS and MAPS systems have been used for certain restricted topics such as human nutrition and post-harvest technology.

Federal funding agencies such as the National Science Foundation, and lately the USDA, have placed emphasis on basic research. Basic research is directed toward increases of knowledge in science where the investigator is concerned with gaining a fuller knowledge or understanding of the subject under study. Applied research is directed toward practical application of knowledge. It covers research where the investigator is primarily interested in a practical use of the knowledge or understanding for the purpose of meeting a recognized need. Development is the systematic use of scientific knowledge and understanding gained from research directed toward the production of useful materials, design systems or methods, including design and development of prototypes and processes.

Most agricultural research represents a continuum from basic to applied, and some development as well. Attempts to clearly delineate basic and applied research have been illusory. Although ill-defined, this criterion is used and projects reported in the CRIS and MAPS systems have been classified in this manner. A little less than 40 percent of the agricultural research projects in the United States are currently classified as basic research.

One of the problems encountered in research management is due to aggregation of individual research activities with the resultant loss of identity of location, specific problems, minor crops and minor livestock species. There may be unique problems associated with them, and although it may be in the nation's best interest to conduct research on them, the loss of identity makes priority setting difficult. For example, crops aggregated under minor crops include guar, crambe, hops, mint, kenaf, lentils, date palm and filbert.

Human nutrition and post-harvest technology research programs have received particular attention recently. Task forces have refined the CRIS and MAPS systems in order to evaluate the current research programs and to assess future needs. An ad hoc committee of the Joint Council of Food and Agriculture used 12 major categories to classify human nutrition research programs. They were based on needs for sound scientific knowledge from which to make dietary recommendations and to guide action programs. An example of this system would be research to determine the effects of menstruation on the iron requirements of young women of college age. It would be classified as regional or national, category 1 nutrient requirements; subclassified for sex and physiological function. Under the CRIS classification system it would be classified under:

Goal VII. Protect consumer health and improve nutrition and well-being of the American people.

RPA 708. Human nutrition.

Activity 6300. Nutritional values, consumption patterns, and eating quality of foods.
6320. Human nutrient requirements.

The MAPS classification would be under NRP No. 20910 Human Requirements for Nutrients.

Post-harvest techology (PHT) research encompasses problems encountered in processing, storage and distribution of agricultural commodities, including food, feed, fiber and fuels from agricultural materials. PHT research is thus a functional extension of the production process and is relevant to the interests of the consumer.

Approximately two-thirds of the cost of food is attributed to processing, storage and distribution. Under the CRIS system of classification, most of the PHT research problems would be grouped under Goal IV Expand the Demand for Farm and Forest Products by Developing New and Improved Products and Processes and Enhancing Product Quality; Goal V Improve Efficiency in the Marketing System; Goal VI Expand Export Markets and Assist in Developing Nations; and Goal VII Protect Consumer Health and Improve Nutrition and Well-Being of the American People. A system designed by SEA/AR specifically for PHT has proven useful. It is described under 12 National Research Programs (NRP's).

An example of PHT research is a study on the starch molecule and methods for chemically modifying it. Starch is a major component of most cereal crops, and increased use of starch could benefit farmers as well as consumers of improved products. The wet and dry milling industries producing starch are composed of many small operators with no research capacity, and a few large operations solely interested in food and feed uses of its products. Research at the SEA/AR Northern Regional Research Center resulted in numerous starch derivatives that have multiple uses. One is Super Slurper, which absorbs 1400 times its weight in water, that has been adopted by several private companies and has over 100 uses in consumer products. This would be classified under NRP 20520: Processing Technologies - Field Crops, or NRP 20650: Technology and Products To Increase Exports of Agricultural Products. This research would be classified in the CRIS system under Goal IV Expand the Demand for Farm and Forest Products by Developing New and Improved Products and Processes and Enhancing Product Quality.

RPA 407. New and improved feed, textile and industrial products from field crops.

Activities 5600. Chemical and physical properties of non-food products.

5700. Developing new and improved non-food products and processes.

Commodities 1400. Corn
1700. Wheat
6700. Plants

Field of Science 1527. Chemistry - physical
1526. Chemistry - organic

It is regional, national or international, and projects span the continuum from basic to applied.

The cooperative, pluralistic, decentralized system of agricultural research management in the United States works well. The State Agricultural Experiment Stations and other cooperating institutions and the federal research units within the USDA such as SEA/AR, FS and ESCS work independently and in concert with private industry to carry out research necessary to provide a dependable supply of high quality food and fiber to consumers, to develop renewable resources for energy and to maintain a quality environment through sound husbandry of natural resources. While units may compete for federal funds, they cooperate with each other and plan together in a systematic fashion where increased emphasis should be placed.

SEA/AR federal laboratories' emphasis is on conducting research on high priority regional, national and international problems and of providing research needed by action and regulatory agencies. State agencies also address these broad issues individually, and collectively, but they place primary emphasis on local, state and regional problems. The definitions in this paper of what constitute state, regional, national and international problems may be of assistance to Congress and high level policy makers. However, this classification system has limited potential for management purposes, and it must be supplemented with a more specific system such as the Current Research Information System (CRIS) and Management and Planning System (MAPS).

Timeliness, specificity, accuracy and flexibility are essential. A system that meets the needs of all performers, including research, extension and higher education/resident instruction activites, nationally, in both government and private institutions, should be developed. The CRIS, MAPS and perhaps the Extension Management Information System (EMIS) should be combined to meet future needs of food and agricultural sciences. Resources would be needed to make possible frequent updating of the data base and rapid retrieval of information, aggregated in a manner needed by Congress and other policymakers, as well as by scientists, research managers, legislators and the general public.

II. INTRODUCTION

Management is defined as "the judicious use of means to accomplish an end." Five major functions included in management are planning, budgeting, execution, assessment and providing support systems and procedures. Information is needed to optimize the utilization of resources, and a classification system is needed to make the information most useful to managers and other decisionmakers.

Agricultural research management involves the systematic allocation and distribution of funds, scientists, support personnel and other resources to be used to seek solutions to problems related to food and agricultural sciences. The term "food and agricultural sciences" is defined in the National Agricultural Research, Extension and Teaching Policy Act of 1977 (Title XIV, PL 95-113), in the broad sense, including "the social, economic and political considerations of:

(a) agriculture, including soil and water conservation and use, the use of organic waste materials to improve soil tilth and fertility, plant and animal production and protection, and plant and animal health;

(b) the processing, distributing, marketing and utilization of food and agricultural products;

(c) forestry, including range management, production of forest and range products, multiple use of forest and range lands, and urban forestry;

(d) aquaculture;

(e) home economics, human nutrition and family life; and

(f) rural and community development."

There are several systems for classifying agricultural research programs for management purposes. These systems will be discussed in some detail in this paper, with advantages and disadvantages of each being given.

The federal/state agricultural research system of the United States is a decentralized, cooperative, pluralistic system. This system of research organization has been eminently effective in serving the needs of America's citizens.

Public investment in agricultural research and extension activities accounted for about 80 percent of the tendency for growth, and from 60 to 70 percent of the tendency for increased efficiency in American food, fiber and renewable resource production between 1929 and 1972 (Pavelis, 1973). A recent article in *Science* by a Yale University economist and his colleagues (Evenson, Waggoner and Ruttan, 1979) attributed much of the success and high rates of returns to investments in agricultural research (about 50 percent per annual rate of return) to the decentralization of research management. They suggested that "a nation bent on increasing productivity by innovation can learn from agriculture."

The American agricultural research management system reflects the philosophy and wisdom of the founders and early leaders of this nation. Thomas Jefferson, Benjamin Franklin, George Washington and other leaders were farmers, and many of them conducted experiments on their own farms and plantations to improve agricultural practices.

When the colonists settled North America they were cautioned to bring seeds with them from their mother country. They also soon began to cultivate native plants, including Indian corn, blueberries, strawberries, cranberries and tobacco. Botanical gardens were established near Savannah, Georgia, Charleston, South Carolina, and other coastal locations for the purpose of testing possible new crops and providing information on their adaptation to the lands of the new colonies. Most of these early test gardens were sponsored by farmer societies or other agricultural groups.

In 1733, Trustees Garden in Savannah, Georgia, was established as a publicly supported agricultural experiment station, and it stayed in existence about 50 years. The first experiments, though local in nature, were international in intent. England desired more silk, so the colonists tried to establish a silkworm industry to meet this export demand. Their early attempts in this "international" endeavor were not successful. However, the introduction of upland cotton was a success, and cotton became the foundation of the agricultural economy of southern states.

Individual statesmen recognized early the importance of expanded plant introduction, but it wasn't until 1819 that official action was taken. President John Quincy Adams, in 1827, mandated our consuls to forward to Washington, D.C. rare plants and seeds for distribution. In 1839, Congress passed its first appropriation for agriculture--$1000--to be used primarily in collecting and distributing seeds. The responsibility for this activity was assigned to Commissioner of Patents in the Department of State.

Also, in 1839, Congress authorized the U.S. Post Office to distribute vegetable seed at no direct cost to U.S. citizens. The Patent Office was transferred to the Department of Interior in 1849. The plant collection activity and the program for free distribution of seeds were transferred to the Department of Agriculture upon its estabishment in 1862.

III. HISTORICAL DEVELOPMENT OF AGRICULTURAL RESEARCH

A. Authorizing Legislation

A comprehensive book on the historical development of agricultural research in the United States, with particular emphasis on authorizing legislation for the State Agricultural Experiment Stations, was published in 1962 in observance of the U.S. Department of Agriculture and Land-Grant College Centennial (Knoblauch, *et al.*, 1962).

Landmark federal agricultural legislation enacted in 1862 and in 1887 provided for: (1) the establishment of the U.S. Department of Agriculture and federal assistance to the states through the Morrill Land-Grant College Act of 1862, and (2) the Hatch Act of 1887 which provided federal assistance for establishing State Agricultural Experiment Stations in connection with the land-grant colleges, to tie in with the USDA. Table 1 (see Appendix) summarizes the more important acts of Congress and executive orders to expand authorizations for food and agricultural research and education programs. These authorizations applied to both federal and state programs.

The Organic Act of 1862, establishing the United States Department of Agriculture, was preceded by considerable debate about the need for "practical and scientific experiments." The new United States Department of Agriculture made slow progress in developing a research program. In 1868, $15,000 was appropriated to the USDA for research on the fever tick. The first organized research unit, the Bureau of Animal Industry, was not established until 1884.

The states took the initiative to fill the federal void in research emphasis. The Connecticut Station, officially established as a State Agricultural Experiment Station in 1875, served as the pattern for other stations to follow in North Carolina, New Jersey, New York, Ohio, Massachusetts, California and Maine.

The Morrill Act, signed by President Abraham Lincoln on July 2, 1862, gave birth to the land-grant college system. The Second Morrill Act of 1890 extended provisions of the Land-Grant Act to historically black institutions of higher education in the southern and border states. In its bicentennial issue, *Life* magazine asked a distinguished panel of experts to list the "100 Events that Shaped America." The Morrill Act was the only social legislation included in the list of one hundred.

The keystone to the strong state-federal partnership in agricultural research and the legislation that laid the foundation of a management system that fostered cooperative research among states and with the USDA was the Hatch Act of 1887. This act authorized the establishment of an agricultural experiment station in each of the states, and provided federal funds to be matched with state funds to support agricultural research. This legislation recognized the importance of having research management decisions made by persons close to the problems. This principle of decentralized management, but with accountability to the federal and state governments, was a necessary ingredient to the success in this system. In a nation with such geographic, climatic and political diversification, a decentralized system was a necessary choice.

The Hatch Act of 1887 established tax-supported agricultural research institutions in connection with the land-grant colleges in the states. The experiment stations were "to promote scientific investigations and experiments respecting the principles and applications of agricultural science. ...and other such researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories."

Each station developed its own research program. The broad latitude of the Hatch Act became the basis for its popularity with groups with divergent views and different needs. Those who favored practical, applied research, as well as those who preferred to emphasize basic research, were served.

The State Agricultural Experiment Stations were given the responsibility of carrying out the above missions to serve the needs of agriculture. This responsibility to serve the needs of agriculture transcends the obligation to the parent college or university. The director of the experiment station was responsible for expenditure of state and Hatch funds and was required to account for them in annual reports to the governor of the state or territory and to the Secretary of the Treasury of the United States.

In the meantime, the USDA also became actively involved in agricultural research. The Bureau of Soils, Bureau of Plant Industry, Bureau of Chemistry and Bureau of Entomology were established between 1902 and 1905, and they moved rapidly in developing research programs. This competition with the states for federal funds lead to heated debates in Congress, preceding the passage of the Adams Act of 1906.

The Adams Act of 1906 provided additional federal funds ($15,000 per year) for State Agricultural Experiment Stations for the purpose of "conducting original researches or experiments bearing directly on the agricultural industry of the United States." This legislation served to emphasize the role of the experiment stations in conducting "basic" research. In discussions leading to the Act, debate included the need for coordination of the work in the several stations, the need to prevent unnecessary duplication of work, to increase efficiency, and to unify and systematize agricultural investigations in the United States. This move toward national centralization of management of agricultural research was opposed. The opposition was due in part to the competition for federal funds that was occurring with the development of USDA federal laboratories. The state stations requested additional federal funds to meet the demands for more sophisticated, long-term research. The appropriations committees were asked to secure for the state stations some measure of equity with federal laboratories in the appropriations for agricultural research.

Cornell's Director, Liberty Hyde Bailey, in 1905, successfully argued in hearings before the House Committee on Agriculture that large, original problems supported by federal grants based on the Hatch principle would properly lie within the scope of state station activity. "So far as possible the origination of the scientific work and the research work should lie within the experiment stations in those regions," stated Bailey. Following this hearing, Secretary Wilson of the USDA proved to be one of the state stations' most effective advocates. He supported the request for additional support for the states and he re-emphasized the importance of continued independence of the state experiment stations.

The passage of the Adams Act in 1906 reaffirmed the principle of local initiative and federal assistance for scientific research of the highest quality in the state stations. It also supplied the opportunity to perform regional research, and held the nationwide network of state stations responsible for the conduct of that research.

Additional expansion of USDA research capabilities resulted from the establishment of the Bureau of Agricultural Economics (1923), Office of Human Nutrition and Home Economics (1923), the Bureau of Dairying (1924), the Bureau of Chemistry and Soils (1927), the Bureau of Agricultural Engineering (1931), the Bureau of Plant Quarantine (1933), the Bureau of Entomology and Plant Quarantine (1935) and Soil Conservation Service (1935). State programs were also expanded during this period.

Passage of the Purnell Act on February 24, 1925, brought about a nationwide program of cooperative research and future development of patterns for regional research. The Purnell Act increased the federal grants for each state and broadened the field of research the stations were authorized to cover. Economic and sociological investigations were expanded.

The Bankhead-Jones Act of 1935 gave special impetus to cooperative research. It provided additional funds which stimulated the research programs of the state stations and cooperative activity. Funding for regional research and further improvements in coordination among states resulted from the Research and Marketing Act of 1946, which was an amendment to the Bankhead-Jones Act of 1935.

Two distinguishing requirements of research conducted under the regional research fund were that the research was to be defined by project plans focused on the solution of specific and important problems of agriculture, and each research project represented a concerted effort involving two or more states in a region.

Within the USDA, the 1950's were characterized by consolidation and reorganization of agricultural research agencies. Between 1884 and 1952 twelve agricultural bureaus were established, two of which represented consolidations of several earlier authorized bureaus. All of the agricultural research bureaus in the USDA were abolished in 1953 and their functions transferred to the Agricultural Research Service (ARS). The on-going activities were assigned to and managed by ARS research divisions, organized according to aggregated commodities, functions or fields of science. The assigned programs included basic and applied research in the biological, physical and engineering sciences concerned with human nutrition, and with national and regional problems for protecting our renewable agricultural resources, developing improved plant and animal germplasm, improving and conserving soil and water resources for more efficient production and for improved post-slaughter and post-harvest handling and processing of meat and meat products, food, feed, fiber and industrial crops.

The Act of 1955 consolidating the Hatch Act and laws supplementary thereto reinforced the intent of Congress to continue to encourage and support agricultural research at state agricultural experiment stations. All previous legislation was consolidated in this Act, including regional research and the appropriation of federal funds for the support of agricultural experiment stations in the States, Alaska, Hawaii and Puerto Rico. The latitude of research to be conducted was reiterated, with special emphasis being stated for research that benefits the consumer, improves the rural home and rural life, as well as contributes to the establishment and maintenance of a permanent and effective agricultural industry of the United States.

The duties of the Secretary of Agriculture were expanded to include "participation in coordination of research initiated under this Act by the State Agricultural Experiment Stations, from time to time to indicate such lines of inquiry as to him seem most important, and to encourage and assist in the establishment and maintenance of cooperation by and between the several State Agricultural Experiment Stations, and between the stations and the United States Department of Agriculture." The Cooperative State Research Service (CSRS) was formed in 1961 to administer federal funds to states for research in agriculture and agricultural marketing, and later, rural development and forestry.

Forestry research, and funds to support state research on forestry, were authorized by the McIntire-Stennis Act of 1962. Title V of the Rural Development Act of 1972 provided funds and encouraged states to increase research and extension programs to rural development. Regional rural development centers were established to further expedite a coordinated effort to obtain solutions to problems in rural America.

Federal-state relations have been competitive as well as cooperative, and a conscious, continuing effort has been made by leaders of the federal laboratories and State Agricultural Experiment Stations to foster active cooperation. A committee of USDA Agricultural Research Service (ARS) leaders and state station directors agreed, in 1960, on the following statement of principles:

"1. That the Agricultural Research Service and the State Agricultural Experiment Stations are individually responsible for accounting for the research results from the moneys appropriated or allocated to them.

2. That the ARS is primarily responsible for research on problems of national and regional concern to agriculture and on those problems involving relationships between the United States government and the governments of other nations.

3. That the State Agricultural Experiment Stations are primarily responsible for research on problems within the borders of their respective states, and for such regional research as is of importance to the area. Statements 2 and 3 are not intended to be mutually exclusive.

4. That basic research is a responsibility both of the ARS and the state experiment stations in each institution and in each area so far as feasible.

5. That ARS and the State Agricultural Experiment Stations will cooperate on a voluntary basis in research whenever cooperative action will be more effective than separate action (regional research will usually be cooperative).

6. That joint planning should be an essential phase of cooperation.

7. ARS and the State Agricultural Experiment Stations will continue to share facilities to the extent that their respective primary responsibilities permit, and will share the operating costs of such facilities as may be mutually agreed upon.

8. ARS and the state experiment stations will examine each of their locations with respect to effective concentration of Federal and state personnel.

9. That, to the fullest extent practicable, necessary adjustments in ARS farm research at field locations be fully explored with the experiment station director concerned before such actions are taken.

10. That negotiations on cooperation be conducted between state experiment station directors and directors of ARS research divisions.

11. That locations for regional concentrations will, so far as possible, be mutually agreed upon by the states in the region and ARS.

12. That, so far as budgetary considerations and other limitations permit, there be a full discussion of needs and plans for additional federal research facilities in the several states.

13. That ARS facilities be located at or adjacent to land-grant colleges or established sub-units thereof unless there are appropriate and compelling reasons for other locations.

14. That the ARS divisions continue to explore opportunities for their maximum contributions to organized cooperative regional research.

15. That ARS, the state experiment stations and other appropriate research organizations, individually and jointly, have responsibility for the evaluation of public programs relating to agriculture with respect to their effectiveness and their consequences." (Knoblauch et al., 1962, pp. 131-132).

These deliberations lead to a series of cooperative arrangements now accepted as standard for the administration of all cooperative research.

The close administrative working relationship between the state directors and USDA has served as the keystone of the arch of effective, whole-hearted cooperation.

In 1972 the Agricultural Research Service was reorganized. This entailed abolishing all of the research divisions and branches within ARS and organizing along geographic boundaries of four regions and a number of areas and centers within each region (see Figure 1 in Appendix). Then, in 1978, the Agricultural Research Service, Cooperative Research Service, Extension Service and National Agricultural Library were consolidated under the Science and Education Administration (SEA) in accordance with the Secretary's order of January 24, 1978, as authorized by the Food and Agriculture Act of 1977 (PL 95-113, Title XIV). The basic functions of the four units consolidated under SEA continue essentially as they were immediately preceding their consolidation except for more cooperation, planning and coordination of budgets and program activities among the units, and the establishment of a Food and Nutrition Center within SEA.

The Congress authorized the establishment of several laboratories and centers including the Beltsville Agricultural Research Center, begun in the early 1940's, the Plum Island, New York, Exotic Animal Disease Laboratory authorized in 1948, and nine special research laboratories authorized by Congress in the mid-1920's. Four of the nine are Regional Research Centers (Wyndmore, Pennsylvania; New Orleans, Louisiana; Peoria, Illinois; and Albany, California), as authorized by the Agricultural Adjustment Act of 1938. Their assigned missions are to develop, through research, new scientific chemical and technical uses, and new and extended markets and outlets for farm commodities, products and by-products. The remaining five have broadly assigned missions reflected in the official names of the laboratory in question. These include: (1) Plant, Soil, Nutrition Lab at Ithaca, New York; (2) U.S. Regional Pasture Research Lab at University Park, Pennsylvania; (3) U.S. Regional Soybean Lab at Urbana, Illinois; (4) U.S. Vegetable Research Lab at Charleston, South Carolina; and (5) U.S. Salinity Research Lab at Riverside, California. Including the 11 facilities just described, there are 145 fully operational federal agricultural research laboratories and stations in the country, each located in close proximity to the problem, watershed or national issue being studied.

The National Agricultural Research, Extension and Teaching Policy Act of 1977 (Title XIV of PL 95-113) noted that agricultural research was not fully coordinated and had been only partially successful in responding to the needs of all persons affected by their research. Useful information produced through such federally supported research, it stated, was not being efficiently transferred to the people of the United States. Areas needing additional research and extension emphasis, including fund authorization levels, were specified. Formula (Hatch) funds, competitive, special and facilities grants, animal health, energy, small farms and aquaculture were specifically mentioned.

Appropriations supporting research at 1890 land-grant colleges, including Tuskegee Institute, were tied to the levels of Hatch funds appropriated to State Agricultural Experiment Stations.

The funds authorized in PL 95-113 for appropriations for agricultural research at State Agricultural Experiment Stations were authorized to increase from $120,000,000 for fiscal year 1978 to $220,000,000 for fiscal year 1982. This endorsement of the Congress for agricultural research by recommending a doubling of federal support during a 5-year period was coupled with the establishment of a mechanism to increase the involvement of users of research and the formulation of a joint council to improve the coordination of research, extension and teaching.

B. Research Institutions and Geographic Areas of Research Problems

State Agricultural Experiment Stations are located in every state in the United States, plus stations in Guam, Puerto Rico, Virgin Islands and Washington, D.C. (see Figure 2 in Appendix). Some states have additional State Agricultural Experiment Stations (Connecticut, New York) so there are currently 56 State Agricultural Experiment Stations authorized to receive Hatch funds. Sixteen Eligible 1890 Institutions and Tuskegee Institute, and sixteen Schools of Forest Resources receive federal formula funds to support portions of their research programs. These are all administered by the same agency--Science and Education Administration/Cooperation Research.

Research programs in the states serve the agricultural commodities and problems associated with the soil, climate and other local conditions. The State Agricultural Experiment Stations have traditionally been responsible to the clientele--farmers, rural citizens and consumers. However, local problems, if not solved, may become regional, national and even international in scope. A plant or animal disease, if not discovered and successfully treated, will spread to other states or nations. A formal system of developing and conducting regional and interregional research has been developed and is used by all State Agricultural Experiment Stations. Federal funds account for less than 20 percent of the support of State Agricultural Experiment Stations, but they provide the incentive and mechanisms of coordination of efforts to solve regional, national and international problems.

Ever since the passage of the Hatch Act of 1887 there has been concern about the extent to which State Agricultural Experiment Stations were to be expected to use these federal funds for research on national problems. This distinction is arbitrary, for there is so much "spillover" of results of even so-called local research that the primary beneficiaries of agricultural research are the consumers of the commodities, and they are frequently in locations far removed from the place where the agricultural commodities are produced (Garren and White, 1980; Ziemer et al., 1981; Ruttan, 1978).

International programs at State Agricultural Experiment Stations have been encouraged, and with the passage of the International Development and Food Assistance Act of 1975, Section 29(a) of Title XII entitled "Famine Prevention and Freedom from Hunger," even greater international activities have been anticipated. Some states have been very active in international programs for many years. Even in states with less direct international involvement, foreign students and graduate assistants are trained. Much of the information developed, particularly the "basic" research, may be transferrable to other nations.

The various USDA research units have carried on research programs on regional and national problems at 145 locations in the United States. Many of these programs are cooperative with State Agricultural Experiment Stations. Fifty to 70 percent of the federal scientists are housed in state facilities and conduct research in state laboratories and greenhouses, and on state-owned land. This cooperation has relieved the state(s) of the responsibility of full staffing with state scientists to properly address those segments of local concern which are part of regional or national issues being investigated by the federal scientists. This long-standing, cooperative working relationship has proven to be mutually beneficial to all cooperators.

It has been a continuing stimulus for scientists to plan and work together in multi-discipline and multi-location team efforts with a minimum of duplication of effort and more efficient use of federal and state resource investments.

The commitment of cooperation led to legislative authorizations which provided close federal/state partnership arrangements. For example, the Research Marketing Act of 1946 authorized the establishment of regional and interregional plant introduction stations with funds and staff to be provided by both the federal government and the various states. Four regional stations were developed in 1947 and 1948 at Geneva, New York; Experiment, Georgia; Ames, Iowa; and Pullman, Washington. Additionally, federal or interregional plant introduction stations include the locations of Glendale, Maryland; Savannah, Georgia; Miami, Florida; and Sturgeon Bay, Wisconsin. The plant introduction stations, plus the National Seed Storage Laboratory at Ft. Collins, Colorado, form the backbone of the U.S. plant germplasm collection, evaluation, development and preservation system. This program is recognized as one of the best systems in the world and is in early stages of being strengthened by federal/state cooperating involving both federal and state funds, and in developing site repositories for maintaining living plant collections of those species normally propagated asexually (rather than by seed). Most important in such collections are tree fruits (both pome and stone), citrus, nut trees, date palms, cane fruits, strawberries, sugar cane and a number of forage crop species.

Also important to the total agricultural research effort are the federal facilities located in areas of regions where specific problems being investigated are most critical or can be investigated. There are 145 such facilities, centers, field stations and laboratories, many of which are equipped with the most modern scientific equipment. These facilities, which are staffed primarily by full-time federal scientists to conduct multi-discipline research on broadly based and often difficult missions, benefit immensely from state and foreign scientists who work in them on shorter term, sabbatical-leave bases or some similar exchange arrangement.

In some instances the federal laboratories are on campuses of land-grant universities (for example, the Soil, Plant Nutrition Laboratory, Ithaca, New York; U.S. Regional Pasture Laboratory, University Park, Pennsylvania; U.S. Regional Soybean Laboratory, Urbana, Illinois; Metabolism and Radiation Research Laboratory, Fargo, North Dakota; Insect, Behavior and Basic Biology Research Laboratory, Gainesville, Florida; Insects Affecting Man Research Laboratory, Gainesville, Florida; Veterinary Toxicology and Entomology Research Laboratory, College Station, Texas; Cotton Insects Research Laboratory, College Station, Texas; Northern Grains Insects Research Laboratory, Brookings, South Dakota; and Poisonous Plants Research Laboratory, Logan, Utah). These research facilities provide day-to-day opportunity for exchanges between federal and state scientists of views on unique and new research approaches for research. Also, federal scientists on campus, whether housed in state or federal facilities, often have adjunct university staff appointments and serve as advisors of university graduate students. These arrangements work to the mutual benefit of the entire scientific community.

The international involvements of SEA/AR are many and cover a diversity of activities. They will be treated according to topical headings as follows:

Overseas In-House Research Laboratories

Currently there are eight overseas laboratories staffed by SEA/AR scientists. Four of these are biological control laboratories concerned with collection, and evaluation of parasites and predators for control of insects and weeds which cause economic damage in the United States. These laboratories are located in Buenos Aires, Argentina; Paris, France; Rome, Italy; and Sapporo, Japan. Additional foreign research laboratories include one on exotic animal diseases in Kenya, Africa; screw-worm fly control in Mexico; Mediterranean fruit fly control in Guatemala; and marketing research in Rotterdam of the Netherlands.

Tropical and Subtropical Food and Agriculture Research

This research began in 1975 as authorized under the Food and Peace Act passed in 1966 and first funded under Section 406 passed in 1974. The legislation indicates the research is to be done domestically but is to involve studies designed to develop information on food production which is mutually beneficial to sub-tropical portions of the U.S. and its territories and developing countries in the tropics and sub-tropics. The on-going research, primarily on tropical and sub-tropical crops and appropriate harmful pests, includes some in-house research at SEA/AR locations and some extramural funds for supporting state research in cooperation with Hawaii, Florida, Puerto Rico, Louisiana and Virgin Islands.

PL 480 Research

PL 480 research is funded with currencies credited to the U.S. in countries from purchases of U.S. surplus agricultural commodities. These programs have been on-going since the 1950's, and until recently, those in agricultural research were managed by ARS. Beginning in FY 1980, the coordination responsibility was transferred to the Organization for International Cooperation and Development (OICD) of the USDA. However, the research responsibility continues with SEA/AR, Forest Service and ESCS. The research responsibility includes review and approval of proposed research from countries having such currencies, and providing the cooperating U.S. scientific guidance essential to monitoring the conduct and progress of the research by foreign scientists in their respective countries. Foreign research proposals funded under PL 480 generally involve research objectives which have potential benefit to the U.S. and the country in question. Further, the cooperating U.S. scientists generally make research site visits during progress of the research being pursued.

Binational Research (U.S. and Israel)

The U.S. government and the government of Israel each made a one-time investment of $40,000,000 and placed the $80,000,000 in an income investment fund for ten years with the understanding funds accrued from the interest would be allocated annually for agricultural research in the U.S. and Israel. All research proposals must be cleared through and approved by BARD (Binational Agricultural Research and Development Board--1977). Public and private research institutions in both countries qualify. During the first two years, $11,000,000 were allocated for approved research with about one-third and two-thirds going to federal and state agencies of the two countries, respectively. The technical responsibility for reviewing, approving and making assessments of U.S. research in progress rests with SEA/AR, whereas managing the funds for the U.S. is now the responsibility of OICD.

Bilateral Research Programs

These are cooperative exchange ventures in mutually agreed on areas of interest which provides opportunity for teams of scientists from the U.S. visiting the foreign country in question and vice versa to review research in progress at selected laboratories and field sites. Currently, the SEA is involved in bilateral research with the USSR, Japan, Peoples Republic of China and Mexico. Forest Service and ESCS have similar programs. The technical overview and scientists visits are a responsibility of SEA, FS and ESCS, whereas OICD has the responsibility for coordinating agreements. These exchanges provide excellent opportunity to learn about new techniques and foreign problems long before the research is published. Also, it affords an opportunity to exchange research materials not otherwise available. These exchanges have opened up areas for plant collections which had been closed to the United States for more than 50 years.

Technical Assistance

USDA scientists have been involved in technical assistance programs overseas for a number of agencies for many years. The most common procedure for providing such assistance is through temporary duty (TDY) of U.S. scientists for several weeks to several months to assist in assessing problems and developing plans for helping developing countries in agricultural research and development. Another type of technical assistance is the Participating Agency Service Agreement (PASA) in which the Agency for International Development (AID) funds the program in the developing country and SEA/AR provides the scientists. Similar arrangements have been made with land-grant universities. The U.S. scientists work full-time in the designated country with foreign scientists who have been selected to serve in apprenticeship modes to learn the techniques, innovations, art and imagination associated with successful research endeavors. Concurrent with this teaching and learning process, the developing country stands to benefit from the research.

Another kind of technical assistance activity by SEA/AR is to provide scientific (sometimes requiring specialized relatively short-term research) and technological assistance to the Foreign Agriculture Service (FAS) of USDA in expanding foreign markets for U.S. agricultural products. Kinds of assistance provided include special packaging of perishables to withstand the handling and delays of overseas shipment, control of stored grain and stored product insects, and determining the causes and time factors involved in abnormally fast deterioration of products during in-transit movement.

Economics, Statistics and Cooperatives Service

The Bureau of Agricultural Economics (BAE) was established in the U.S. Department of Agriculture in 1922 (Baker et al., 1963, and Baker and Rasmussen, 1975) to help farmers solve their serious price and income problems as a result of the disastrous post-World War I drop in farm prices. In early years research of the BAE emphasized collection and analysis of data on production, price and market of farm products. To assure that farmers benefitted from this early effort and the interpreted analyses, the first annual outlook conference was held in April, 1923. The outlook conferences have been a continuing annual activity since that time.

While achievements of the BAE, as viewed by persons in the political arena, have encountered many "ups" and "downs," it appears that greatest recognition for the Bureau's achievements occurred during periods when agriculture and farmers experienced stress and change. The high point of its activities was reached in the 1930's when it developed information which formed the basis of the major New Deal agricultural programs and policies. The BAE's economic staff work during World War II, for both the War Food Administration and the Secretary of Agriculture, proved indispensable to wartime food and agriculture production. However, the Bureau's influence in government policy and on agriculture began to decline sharply shortly after World War II. The BAE was abolished in 1953 as part of an announced major reorganization of the U.S. Department of Agriculture.

The functions of the abolished BAE were divided between two new agencies--namely, the Agricultural Marketing Service, which assumed responsibility for the marketing and transportation research, and the Agricultural Research Service, which was assigned the production economics and farm management research. In 1961 all economics research of the AMS, ARS and FAS was concentrated in the Economic Research Service (ERS). From that time forward many changes in economic research thrusts and programs evolved to keep abreast of a rapidly changing social and economic structure in agriculture. In December, 1977, there was a further consolidation with the establishment of the Economics, Statistics and Cooperatives Service in the Department of Agriculture.

Forest Service

The concern for protecting and conserving timber of colonial lands began in 1626. Early in the 18th century there began a series of actions establishing community forests. Colony and state prohibitions against setting fire to woods began about the time the States declared their independence in 1776. A number of state and federal acts concerning timber purchase, preservation, reservation, cultivation and survey followed. The first federal timber agents were appointed in 1850 under the Department of Interior. The first real work on forestry began in 1876 when Congress authorized the appointment of a special forestry agent. Congress granted its first appropriation, $6000, to obtain information before establishing a Division of Forestry in the Department of Agriculture. Until 1905, the Department of Interior was responsible for administration of national forests, with the USDA Division of Forestry providing technical advice. The first research in the Division of Forestry was in 1898 and involved six scientists. Congressional Act of February 1905 (33 Stat. 636) provided for the forest reserves and forestry related activities in the Department of Interior to be transferred to the Department of Agriculture, which shortly thereafter put all forest activities under the Forest Service.

Although the Forest Service charter is not considered as being directly involved in food and agriculture research (the focus of this OTA assignment), it is involved in activities which have relevance. Specifically, the ranges in national forests which are researched and managed by the Forest Service contribute significantly to the forage base for domestic livestock in rangeland areas, and these animals provide a significant portion of red meat available to consumers. Further, in this era of a worldwide energy crisis, biomass from trees loom big on the horizon as a potential source of energy, thus sparing more of this country's grain supply from use as a feed stock for fuel alcohol production and thereby assuring sustained adequate quantities of grain for human food.

National Science Foundation

The primary purpose of the National Science Foundation (NSF), established by an act of Congress in 1950 (64 Stat. 149; 42 U.S.C. 1861-1875) as a fund-granting agency is to increase the nation's base of scientific knowledge and strengthen its ability to conduct scientific research. The NSF initiates and supports fundamental and applied research in all of the scientific disciplines. Much of the research it supports is to resolve scientific questions concerning fundamental life processes, natural laws, phenomena, fundamental processes influencing man's environment and the forces impacting on people and their behavior in society. Some funding also supports research on selected social problems. Research funds are made available through grants, contracts and other agreements to universities, nonprofit agencies and other research organizations.

Environmental Protection Agency

The Environmental Protection Agency was established in the Executive Branch as an independent agency pursuant to Reorganization Plan No. 3 of 1970, effective December 2, 1970. It was created to permit coordination and effective governmental action on behalf of the environment. While its function is primarily regulatory, it does have a research and development activity to provide baseline scientific information important to establishing contaminant tolerances essential to promulgating and enforcing pollution control regulations. The EPA Research and Development Program office is responsible for a national research program in pursuit of technological controls of all forms of pollution, including that associated with all aspects of farming and agricultural production.

Department of Energy

The Department of Energy, established by Act (91 Stat. 569; 42 U.S.C. 7131) pursuant to EO 12009 of September 12, 1977, consolidated the federal energy functions from a number of agencies and departments into one cabinet-level department. Although a new department, it has a sizeable and expanding research program, much of which currently is extramural with some pass-through funding to other federal agencies. It supports research, development and technology demonstration in all energy areas, including solar, geothermal, fossil and nuclear energy. The energy research activity is important to agriculture because of the energy required for a healthy, efficient and dependable agricultural industry, and the potential use of grains and plant biomass as stock materials for producing non-fossil fuels.

Health and Human Resources

The Department of Health, Education and Welfare was created on April 11, 1953. In 1980, the education functions were transferred to a new Department of Education and the former HEW was renamed Department of Health and Human Resources (HHR). While many of HHR's activities involve action, regulatory and human services programs, it does have a substantial effort on intramural and extramural research. A small portion of the HHR research impacts on agriculture, namely some of the effort on food standards and contaminants, basic research on recombinant DNA and cancer research. HEW provided funds for a number of years to make worldwide collections of plants in search of anti-cancer properties in plants.

Department of Defense

While the Department of Defense is responsible for providing the military forces needed to deter war and protect the security of our country, it supports much research extramurally, primarily for research and development of weapons. Also, it has concern over protecting its stores of provisions for the army and protecting the armed forces against insects--particularly those which might be vectors of human diseases. For many years the DOD has provided funds to ARS and SEA/AR to evaluate insecticides and other materials for effectiveness against insects destructive of wool and other fibers used for clothing and bedding, and against insects affecting man. In emergency situations, the DOD requests TDY's for SEA/AR scientists to give technical advice in coping with spontaneous, serious problems which require biological and physical sciences training and experience. Late in the 1970's, when by Executive Order the military closed out its biological warfare research program, the DOD requested expert technical assistance from ARS regarding guidelines, plans and scientific supervision for destroying biological warfare materials (potent pathogens against food-producing plants) without endangering the agricultural industry, the environment, or American citizens.

Department of Interior

The Bureaus of Land Management Reclamation and of Sport Fisheries of the Department of the Interior (DOI) have, for many years, provided funds through Memorandums of Understanding to ARS and SEA/AR scientists and to State Agricultural Experiment Stations to support research to develop technology useful for managing and improving rangelands, reclaimed lands and for control of aquatic weeds. This is vital to DOI because of its assigned responsibility for managing the non-forested rangelands and protecting water impoundments and transport systems in the federal domain.

C. Research Planning

State Research Planning

Research planning is a continuous process at each of the State Agricultural Experiment Stations. Formal input from committees composed of faculty, department heads, extension specialists, agricultural commodity leaders, consumer groups and others is sought. One of the strengths of the land-grant college system is that research, extension and teaching functions are intermeshed, resulting in a constant feedback of research needs from the field. It is this "articulation" or "state of being systematically interrelated into a whole as by joints or messages" that was achieved by the Morrill, Hatch and Smith-Lever Acts.

In the American land-grant college system there are connections and communications between and among those involved in theoretical research, practical research and dirt farming (Evenson, et al., 1979). State directors are in direct contact with farmers, faculty, state legislators and others who are aware of problems and special needs. The procedures used by states to develop plans based on these priorities will be discussed in other OTA papers, particularly the one by Huston (1980). The Current Research Information System (CRIS) is the most common data base used by state directors to analyze allocation of resources to commodities, activities, field of science and special categories. The extent to which this information is used in developing plans within states varies, but it is a resource available to all directors and their staff.

Research planning within the states has primarily been the responsibility of the director and staff of the State Agricultural Experiment Stations. Cooperative relationships with other state and federal laboratories have resulted in formal research planning procedures. In those states with Eligible 1890 Institutions, the director of the State Agricultural Experiment Station and the chief administrative officer of the 1890 institution were requested in the Food and Agriculture Act of 1977 (PL 95-113) to develop a comprehensive program of agricultural research. In most, if not all, states such cooperative planning includes federal laboratories as well as stations in other states. A 5-year program plan is prepared biannually and is compiled under the auspices of the Joint Council on Food and Agricultural Sciences. The 1979-1984 plan is the most recent one to have been completed and will be discussed in a later section of this paper.

The following is one example of research program development on the state level. A committee, composed of four division chairmen with administrative responsibilities for research, extension and teaching, plus a permanent chairman, comprise the Research Program Committee. Each committee member is responsible for three to four disciplines and they obtain suggestions of priorities for research needs for the next 5 years from these departments, users of research and others.

Economic data on the major and minor commodities grown in the state, including farm income, value-added and projected economic value, are compiled annually for comparison with the current allocation of research resources. This analysis is only one input, but it provides useful information to the committee and directors.

The committee not only receives feedback from other scientists and administrators, but also from commodity and farm organizations, extension specialists and county extension personnel, consumers, state legislators, university system administrators and other leaders. The national and regional priorities that are expressed through formal communications channels are also part of the planning process.

The programs of research at the Eligible 1890 Institution and the SEA/AR USDA laboratories in the state are also taken into consideration. For instance, if USDA SEA/AR scientists are conducting research on peanuts, weeds and other areas, the state research program is planned to complement, rather than duplicate or compete with, federal scientists. Likewise, the areas of research emphasis at the Eligible 1890 Institution have been developed, by mutual consent, after numerous meetings with State Agricultural Experiment Station personnel. Planning is done in a systematic, orderly fashion, and the plans for both institutions are updated annually.

Annual budget preparations for the State Legislature, the Governor and the University System involve planning, with information being requested by each. Commodity groups and farm organizations interested in the research programs are also informed of aspects of concern and interest to them. A statewide organized planning effort was held, and citizens from throughout the state were involved in intensive planning sessions, resulting in specific, long-range plans being developed. These goals were incorporated into the decision packages used to justify state budget requests.

Planning within each of the departments and other budgetary units within an experiment station is a continuous process. Every 4 to 5 years there is a comprehensive review by an outside group of peers and SEA/CR personnel, and this is preceded, as well as followed, by planning sessions.

Each research project that is initiated by an individual scientist is approved only after evidence of thorough planning and peer review, as well as administrative review. Most projects are approved for a 3- to 5-year period, so each year 20 to 33 percent of the state agricultural research program is subjected to review, and plans modified to take into consideration the changing problems, resources available and opportunities for advancing man's knowledge of the forces of nature, economics and other factors that affect agriculture and the quality of life.

In all land-grant universities there is a comprehensive self-study every 10 years that is required for accreditation. The study involves every department and every college. Individual disciplines may also have special reviews or professional accreditation reviews in addition to the SEA/CR reviews.

In addition to the research planning that occurs within each State Agricultural Experiment Station, and planning that is reported through formal administrative channels to USDA SEA/CR, there is another planning process by the Experiment Station Committee on Policy (ESCOP) Legislative Subcommittee federal budget request for the State Agricultural Experiment Stations, Eligible 1890 Institutions, and Schools and Colleges of Forest Resources, Home Economics and Veterinary Medicine. This subcommittee includes representatives from the agricultural experiment stations in each of the regions as well as representation from 1890 institutions, home economics, forestry and veterinary medicine. The committee prepares plans for future budget requests, based on perceived needs of the groups they represent. The administrators' 5-year projections of research plans are a vital part of the budget preparation, as are the signals received from the Executive Branch (Secretary of Agriculture, President, OMB) and previous appropriations from Congress. High priority areas are identified (energy, integrated pest management, formula funds to maintain programs, etc.) and budget requests are based on these. Professional USDA staff are involved year-round in developing the SEA budget and supporting materials, and the ESCOP Legislative Subcommittee has opportunities to interact with them in developing the budget. This ESCOP budget and associated plans are subjected to review and approval by the Experiment Station Section, Division of Agriculture and the National Association of State Universities and Land-Grant Colleges (NASULGC).

Federal USDA Research Planning

National program reviews and workshops (PRW's) are preplanned according to established procedures (Directive 600.6 issued September 26, 1979) and designed to coordinate this total activity in a manner that assures orderly, comprehensive and periodic assessment of all SEA/AR research programs. The procedures provide for developing "annual plans" and "documentation" as required by the Office of Management and Budget, and the Joint Planning and Evaluation staff of the SEA. The advanced scheduling provides maximum flexibility for greatest possible participation in the review process by line managers, National Program Staff (NPS) and scientists.

The "program reviews" are classified as multi-location, single location or special location and are organized to evaluate the relevance of current and projected research in terms of the SEA's missions and established priorities to assess progress and productivity, to determine the effectiveness of team research and cooperative endeavors, to consider the assignment of personnel and the allocation of resources and facilities, to consider the need for program changes and redirections, and to develop recommendations designed to strengthen the research program(s) being reviewed as well as the total research mission of SEA/AR.

The multi-location reviews assess programs involving SEA/AR scientists at more than one location, and usually are organized by the NPS in consultation with SEA/AR scientists and line managers, and may include other government agency representatives, scientists from universities and representatives from private industry. Conversely, single location reviews differ from the multi-location reviews only in that the total research program for the location is assessed. In case of large centers, the assessment may involve only a segment of the total program.

Special reviews involve specific program at individual work locations. The documentation of reviews and recommendations are timely and involve a minimum of paperwork and red tape. All interested parties are advised of scheduling, proposed actions resulting from the review and follow-up for their accomplishment.

The SEA/AR workshops are intended to be problem-solving or research-planning meetings devoted to specific topics and may be functional or commodity-oriented in nature, and national, regional or local in scope. They are intended for review of the "state of the art" by scientists with expertise in the particular field or discipline reviewed, and to provide opportunities for scientist-to-scientist interchanges.

All agencies within the USDA are expected to plan, organize, document, implement, carry out and report their activities in conformity with the missions, goals and programs of the department. The 10 missions of the USDA represent the responsibilities and duties assigned by law and regulations, and cover the array of activities designed by agencies to help carry out the department's assigned role in solving broad national problems. In recent times the 10 missions were divided into 41 operating goals, comprising a total of 288 contributory programs. However, the department goals and programs within the 10 missions change periodically in keeping with changing national priorities and problems.

The Agricultural Research Service Management and Planning System (MAPS) implemented in the mid-1970's, and still in use (1980), is the support system for planning and managing the agencies' research. MAPS comprises five major functions--namely research planning, reporting, evaluating, budgeting, and executing research. MAPS, which will be described in more detail later in this paper, provides for a unified and effective program management system which permits organizational entities within the agency to simultaneously meet the needs of agriculture, society and its scientists. Further, it outlines the responsibilities for research leadership and coordination within the agency at the national level. The system is simple and flexible. Scientists working within their assigned research program may use their ingenuity and imagination in conducting innovative, creative and useful research. People, rather than systems and procedures, formulate research goals and plans and develop strategies for their implementation.

The Economics, Statistics and Cooperatives Service (ESCS), like other USDA agencies with research responsibility, has a detailed and intricate research planning activity. It has a bona fide representation on and participates in the National and Regional Planning Committees of the Joint Council on Food and Agricultural Sciences. This assures coordination with counterpart state and industry economic research activities. In addition, ESCS has its own Internal Research Program Planning Process to accommodate the department's budget development, review and approval procedures. This process provides for Internal Decision Units (IDU's), each with minimum and increased levels of funding as required for decisionmaking within the Zero Base Budgeting (ZBB) concept being used within the USDA and other executive branch departments. Within IDU's there are smaller identifiable and trackable units described as Managing Information System (MIS), each with clearly defined objectives and activities to facilitate development of research plans. These feed into the budget process for decisionmaking based on high priority goals and programs of the department.

Research planning for Forest Service, USDA, is also included in the comprehensive planning activities instituted originally by the Agricultural Research Policy and Advisory Committee (ARPAC) and recently assumed by the Joint Council on Food and Agricultural Sciences and its Regional Planning Councils. Similarly, Forest Service must tailor its internal plans to meet the USDA annual budget development requirements according to department missions, goals and programs within the ZBB concept of budget analysis. Critical to the Forest Service research planning is that it must tie in with the mandates of the Resources Planning Act recently enacted by the Congress.

Cooperative State and Federal Research Planning

Cooperative state and federal research planning is accomplished through the Joint Council on Food and Agricultural Sciences, Regional Councils and conferences between the Science and Education Administration/Agricultural Research (SEA/AR) area directors and regional administrators, representatives of the Economic, Statistical and Cooperatives Service (ESCS) and State Agricultural Experiment Station (SAES) directors and the Eligible 1890 Institutions research directors. Forestry research and agricultural economics research also involve conferences between the Forest Service Experiment Stations and state university forestry departments (ASCUFRO), the ESCS and the university agricultural economics departments, respectively. Scientific and professional organizations play a major role in joint planning between federal, state, industry and other private organizations. Also scientist-to-scientist contact constitutes a major planning role between state, federal and private organizations. This is done on a personal basis and through professional societies. While the formal organizations are usually cited to show how planning is accomplished, the importance of voluntary cooperation among scientists should be encouraged and not be overlooked as an important entity.

The Joint Council on Food and Agricultural Sciences was established under authorization of Section 1407 of Title XIV of the Food and Agriculture Act of 1977. The Joint Council replaced the former Agricultural Research Policy Advisory Committee (ARPAC). Membership of the Joint Council includes representatives of the U.S. Department of Agriculture agencies, the Office of Science and Technology Policy, land-grant colleges and universities, State Agricultural Experiment Stations, State Cooperative Extension Services, other colleges and universities, foundations, private industry, producers and the public. The primary purpose of the Joint Council is to foster planning and coordination of agricultural research, extension and teaching activites among all participants in the system.

In addition, it provides a forum for the interchange of information among organizations represented on the Joint Council; analyzes and evaluates the economic, environmental and social impacts of agricultural research, extension and teaching programs; defines high priority agricultural research areas; and reviews the effectiveness of the system. The Council is also charged with developing and reviewing the effectiveness of guidelines for use in making competitive grants.

The Joint Council is currently jointly chaired by the director of Science and Education, USDA, and a representative of the land-grant colleges. In 1978, the Joint Council appointed an Interim National Research Planning Committee (NRPC) and instructed it to continue the research planning efforts of the regional and national agricultural research planning system that was established in 1976 by ARPAC.

There are four Regional Councils, representing the Northeast, Southern, North Central and Western regions of the United States. Each of the Regional Councils have planning and coordination committees for research, extension and teaching.

The Regional Research Planning Committees are responsible for assembling the 5-year-cycle projections from the state and federal research administrators in each region. These reports give the state and federal research effort projections for each research program for a 5-year cycle. The projections are expressed by each research manager based on zero change in scientific-person years (SY's) and a 20 percent increase in SY effort. The 5-year projections are revised every 2 years. The regional projections are then reported to the National Research Planning Committee for assembly and analyses.

Each Regional Research Planning Committee operates so their report can be combined, but also has enough flexibility to allow for differences due to regional differences. For example, the Southern Research Planning Committee (SRPC), in addition to assembling the administrators' 5-year projections, has developed lists of high priority research areas needed for southern regional agricultural development. To help with developing this list of priority needs, the SRPC encouraged the formation of the Southern Research Users Groups (RUG). The RUG develops a list of research needs and presents them to the SRPC. The SRPC then makes a list of research needs in priority order and recommends action toward implementing the recommendations through the SAES directors and the administrators of the federal agencies. A recent example of more detailed planning from this process was a forage-livestock research planning document prepared by a multidisciplinary scientist team at the request of the southern State Agricultural Experiment Station directors and the SEA/AR regional administrators. This document is now being used by federal and state researchers in their research livestock interactions.

In addition, the SRPC has encouraged "mini" conferences between two to four states at a time, but including all states and territories in the southern region with all state and federal administrators of research programs participating. In these conferences the state and federal administrators reviewed their planning procedures, reviewed the on-going research, and both federal and state administrators rated the research as high, higher and highest priority to give their cooperators an idea of their feeling for various research programs. They also revealed to each other their plans for the future. This procedure is very effective in eliminating duplication and encouraging cooperation in focusing on the research that, in the view of the administrators, will be of the greatest benefit to agriculture in the southern region.

For a number of years the states and federal agencies have been involved in many regional and some interregional research projects. These projects focus on specific problems such as pecan insect control, soybean breeding and cotton mechanization as examples of regional projects, and integrated pest management and plant introduction as examples of interregional projects.

IV. CLASSIFICATION OF RESEARCH PROBLEMS USED IN THE MANAGEMENT OF AGRICULTURAL RESEARCH

Classification of agricultural research problems for use in the management of agricultural research is a complex process. The classification system must meet the needs of several administrative groups, each performing a part of the administrative process. It must also be useful to those responsible for allocation of resources, such as legislators. It must also meet the needs of the scientists involved.

The scientist is a manager and he/she makes some major decisions regarding the research to be accomplished. The scientist must consider various problems or opportunities related to agriculture, determine the current knowledge on the subject, select the appropriate technology to solve the problem, determine whether the technology is in their area of competence, assess the resources available and determine whether they have the authority from their organization to do the research.

The head of a department of a State Agricultural Experiment Station or a research leader of a federal agency usually has responsibility for a discipline, commodity area, function area or resource area. They must put researchable problems in their areas of administration into priority order. They use these priorities to determine what should be continued, what terminated and what can be started with the resources available.

The SAES directors and the area directors of SEA/AR have the administrative responsibility for the research conducted by their agencies. Most SEA/AR area directors are administratively responsible for two or more states. The four federal Regional Research Center directors have national responsibilities for research (mainly processing) on commodities produced in their particular region.

The regional and national administrators of federal agencies have the responsibility for the conduct of research by their respective agencies. The regional and national SEA/AR administrators work as a team to administer the total program, with the AR administrator having the final responsibility and authority for AR, and the director of Science and Education having the final responsibility and authority for SEA.

The Office of the Secretary of Agriculture has final responsibility and authority for administering agricultural research done by the agencies of the USDA. This includes responsibility of overview of the use of federal funds appropriated to the states and for contract funds.

Congress has the responsibility for examining the budget submitted to them by the Executive Branch, examining information submitted to them by the individuals or organizations, and from their own knowledge, appropriating the federal funds which are used to support agricultural research. They also have oversight for determining that results are being obtained by the money appropriated.

The criteria to be considered in classification of research should include sponsors, specific benefits and the beneficiaries. Sponsors are local, state and national governments, and private enterprises. Beneficiaries are farmers and ranchers, processors, marketers, consumers, or a combination of all of these. The benefits are economic, environmental, social or national security. Any classification system must provide a common terminology for both scientist and administrator.

One system of classification is local and state, regional, national and international. A rationale for this system is to have a method for determining the responsibility of state and federal agencies for specific agricultural research problems. Historically, states were appropriated federal funds, distributed by a formula based on rural population and number of farms, to conduct research on state and local problems occurring within their states. In general, federal agencies work on regional and national agricultural problems in cooperation with the affected states. The people affected by the agricultural problem usually do not care who solves it; they just want the solution as quickly as possible. Most scientists are interested in solving problems and/or developing new knowledge and care little about the source of funds. Administrators, though, are responsible to their organization, so some classification system must be used for policy and/or to help with communications between the various levels of administrators for orderly and effective decisionmaking.

Research in any field is the asking of carefully structured questions and the answering of those questions by precise methods of science. Agricultural research is a systematic method of gaining and applying knowledge efficiently to the biological, physical and economic phases of producing, processing and distributing farm and forest products; consumer health and nutrition; and to the social and economic aspects of rural housing (National Program of Research for Agriculture, 1966).

An agricultural research problem is defined as a problem affecting agriculture for which sufficient knowledge does not exist for its satisfactory solution, and which can probably be solved through the development of new knowledge. The following are definitions and examples of state and local, regional, national and international research problems.

A. State and Local

Any problem related to agriculture that occurs within a state or portion of a state is defined as a state or local problem.

- Determination of crop and animal adaptability to various locations and soil types within a state. This includes selection and breeding of crops and animals for various microclimates.
- Determination of fertilizer and irrigation requirements of crops in various parts of the state.
- The identification and control of crop and livestock pests within various parts of a state.
- Research problems related to the processing and marketing of agricultural products produced within a state.
- Determination and development of technology that fits the desires and customs of the people living within a state.

B. Regional

Any problem related to agriculture that extends over a major portion of two or more states within a region or affects the economy, environment or social needs of the major portion of two or more states within a region is defined as a regional research problem.

- Migratory pests or diseases that affect the major portions of two or more states of a region. Southern corn blight is an example. It affects corn in several states in the southern region.
- Development of plant varieties sensitive to a specific photoperiod and ecology. An example would be the development of soybeans, specifically for the Coastal Plains of southeastern U.S.
- Research problems related to the development of markets in a specific region.
- Research to determine and solve the problems of off-flavor catfish grown in several states in a region.
- Research related to the production of grass-fed beef in a specific region.

C. National

Any researchable problem that extends over a considerable portion of more than one region or has a major impact on the economy, environment or social conditions of more than one region is defined as a national research problem.

- Migratory pests or diseases that affect major portions of two or more regions. An example is the fall army worm. This insect overwinters in southern Florida on vegetation, including a number of weed species. It does some damage in Florida, but also does a great deal of damage in other states of the southern region and in states of the north central region. Therefore, this research problem should be attacked from a national basis and should not be left to Florida alone to solve.
- Development of erosion principles--water and wind applicable to two or more regions.

D. International

Research problems that affect the agriculture of two or more countries and can be solved best by the cooperation of the countries affected are defined as international research problems.

- Problems related to the control or eradication of the screw worm, an ectoparasite of livestock, and seriously affects the production of livestock. This insect overwinters in Mexico and, if not controlled, spreads into the United States. It is presently being attacked in Mexico by a joint effort of government agencies in Mexico and the United States.

- Problems related to the control of insects in commodities shipped to various foreign countries and control of insects in agricultural materials imported into the U.S.

- Research related to the standardization of machines for agricultural production to be exported from and imported to the U.S.

V. PRESENT METHODS OF DIFFERENTIATING RESEARCH PROBLEMS

A. Current Research Information System (CRIS)

The present classification system used for agricultural research management in the United States is one that was developed by the United States Department of Agriculture and experiment station leaders. It is commonly known as the CRIS system (Current Research Information System). The system is described in detail in the Manual of Classification of Agricultural and Forestry Research (1978). It classifies research by Research Problem Areas (RPA), Research Programs (RP) and Research Program Groups (RPG). A second feature of this classification system is the three-dimensional scheme of describing research by activity, commodity, resource or technology not commodity-oriented, and field of science. Activity describes the purpose or nature of the research activity; commodities, sources or technology--not commodity-oriented--are indexed in a second dimension; field of science denotes the disciplines employed in doing the research.

Because of local, regional, national and discipline interests in special research programs, a number of additional special classification categories are also available for more specific identification of research. These include topics such as energy, water resources, pesticides, home economics and special categories such as those related to pollution, weather, health, nuclear radiation and others.

The CRIS classification system is used to report all the current research problems of USDA agencies, State Agricultural Experiment Stations and other agricultural research conducted by non-land-grant universities. It is used for state, regional and national planning purposes. The CRIS system is used by scientists to give them information on where and by whom research of interest to them is being conducted, and it provides them with some information on methods and procedures, scope of the research, and progress to date. It gives managers a tool to assist them in planning programs and in avoiding unnecessary duplication. Legislators and government officials use the system to see where publicly supported agricultural research resources are being allocated. Commodity group leaders and special interest groups may also use the inventories based on CRIS reports to compare the expenditures with perceived needs.

The CRIS system of classification is the basic method used by all publicly supported agricultural research units in the United States to report how state, federal and private sources of funds were used. Hatch, McIntire-Stennis and federal funds allocated to Eligible 1890 Institutions on a formula basis are accounted for annually by means of CRIS reporting units. The federal laboratories, which receive federal funds earmarked for specific purposes, also use CRIS reporting units as the source documents to aggregate into Work Reporting Units (WRU) and National Research Programs (NRP).

An integral part of regional and national planning of agricultural research is aggregation of the total program of research into manageable units and subunits. The CRIS system is used for this purpose as follows: There are 98 Research Problem Areas (RPA) grouped under the nine Goals of Agricultural Research identified in the Long Range Study, A National Program of Research for Agriculture (1966). These goals, and examples of CRIS Research Problem Areas (RPA) are:

GOAL

I. Insure a stable and productive agriculture for the future through wise management of natural resources. There are 14 Research Problem Areas (RPA) included. Ex. RPA 101 Appraisal of Soil Resources.

II. Protect forests, crops and livestock from insects, diseases and other hazards. RPA's 201-214. Ex. RPA 201 Control of Insects Affecting Forests.

III. Produce an adequate supply of farm and forest products at decreasing real production costs. RPA's 301-318. Ex. RPA 310 Reproduction Performance of Livestock, Poultry and Other Animals.

IV. Expand the demand for farm and forest products by developing new and improved products and processes and enhancing product quality. RPA's 401-412. Ex. RPA 406 New and Improved Food Products from Field Crops.

V. Improve efficiency in the marketing system. RPA's 501-513. Ex. RPA 508 Development of Domestic Markets for Farm Products.

VI. Expand export markets and assist developing nations. RPA's 601-604. Ex. RPA 603 Technical Assistance to Developing Countries.

VII. Protect consumer health and improve nutrition and well-being of the American people. RPA's 701-709. Ex. RPA 703 Food Choices, Habits and Consumption.

VIII. Assist rural Americans to improve their level of living. RPA's 801-808. Ex. RPA 807 Structural Changes in Agriculture.

IX. Promote community improvement, including development of beauty, recreation, environment, economic opportunity and public services. RPA's 901-908. Ex. RPA 902 Outdoor Recreation.

X. Enhance the national capacity to develop and disseminate new knowledge and new or improved methodology for solving current problems or new problems that will arise in the future. Research under Goal X is conducted under all the RPA's of Goals I-IX.

Each CRIS project is also classified by activity, commodity, field of science. Examples of each are:

Activity Number	Description
4100	Resource description and inventory
4830	Protection against pollutants
5000	Improving biological efficiency of plants and animals
5410	Chemical and physical properties of foods
6320	Human nutrient requirements
6730	Adjustment to social change
7500	Development of research equipment and technology

Commodities, etc.	
1400	Corn
1900	Pasture
2900	Poultry
3100	Dairy cattle
3700	Clothing and textiles
4600	Farmer cooperatives
6300	Biological cell systems

Examples of Field of Science:

Code	Field of Science
0312	Biology-Molecular - plant
0410	Entomology - animal
0512	Plant genetics and breeding
0812	Nematology - plant
1310	Physiology - animal
1527	Chemistry - physical
1920	Engineering - agricultural

Examples of Special Classifications:

Code	
E	Energy-related
HE	Home Economics research
PST	Pesticide targets
XPR	Pollution-related
XWR	Weather-related

In preparing inventories for planning purposes the CRIS reporting units usually are aggregated into 48 Research Programs (RP) and these, in turn, into nine Research Program Groups (RPG). Examples are:

RPG	
1.00	Natural Resources RP's 1.01 - 1.07. Ex. RP 1.01 Soil and Land Use
2.00	Forestry RP's 2.01 - 2.09. Ex. RP 2.03 Forest Protection
3.00	Crops (Field and Horticultural) RP's 3.01 - 3.16. Ex. RP 3.14 Vegetable Crops
4.00	Animals RP's 4.01 - 4.07. Ex. RP 4.01 Beef
5.00	People, Communities and Institutions RP's 5.01 - 5.05. Ex. RP 5.03 Rural Development and Quality of Family Living
6.00	Competition, Trade, Adjustment, Price and Income RP's 6.01 - 6.03. Ex. RP 6.01 Farm Adjustment Price and Income
7.00	General Resource or Technology RP's 7.01. General Resource or Technology
8.00	Food Sciences and Human Nutrition
9.00	Unclassified

An example of the use of the CRIS classification system is research on coating cotton for open-end spinning. It would be classified as follows:

Goal V: Improve Efficiency in the Marketing System

- Research Program Area (RPA) 501, Improvement of grades and standards - crop and animal products
  - Activity 5600, Chemical and physical properties of non-food products
    - Commodity 2100, Cotton
      - Field of Science 1525, Chemistry - inorganic

It would be summarized under Research Program RP 6.03 Marketing and Research Program Group, RPG 6.00 Competition, Trade, Adjustment, Price and Income.

The CRIS system of classification includes human nutrition research, under Goal VII: Protect Consumer Health and Improve Nutrition and Well Being of the American People. A number of Research Problem Areas (RPA) are applicable, including RPA 708, Human Nutrition. The activities appropriate to this RPA include:

5500	Developing new and improved food products and processes
6300	Nutritional values, consumption patterns and eating quality of foods
6320	Human nutrient requirements
6360	Metabolism and function of nutrients
7300	Evaluation of public programs, policies and services

Classification by commodities includes practically all of the plants, animals and other edible products.

The CRIS Committee of the Joint Council has approved, effective immediately (October, 1980) an expanded activity classification in the area of food sciences, human nutrition and human resources. Planning has been expanded by taking from Research Program Group (RPG) 5.00 all projects that deal with food sciences and human nutrition to make a new RPG 8.00 (Food Sciences and Nutrition). This change in program structure was possible without any change on the CRIS forms, and illustrates how the CRIS system may be useful for planning purposes even with changing priorities and emphasis.

B. SEA/AR National and Special Research Programs

Management and Planning System (MAPS)

The Agricultural Research Service (Now SEA/AR) developed the Management and Planning System (MAPS) which described its component research programs for planning and evaluation. This is a device for organizing the subject matter of research so that it relates most effectively to the activities and plans of the agency. It provides the framework for the supporting systems and information needed for planning, reporting, evaluating, budgeting and executing research.

The Program Structure (MAPS) is a logical continuation of the Department Program Structure that extends to the individual research projects. It consists of missions, goals, programs, ARS (now SEA/AR), national research programs, work reporting units and research projects. The 10 missions describe the department's role in solving broad national problems, and the 41 goals define this role. The SEA/AR has 12 national programs (288 in the department) which specify the general plan of action for achieving the goals--eight for the domestic program, two for the foreign program, and two for administrative functions. The areas of research are classified into 67 SEA/AR National Research Programs (NRP) and eight Special Research Programs (SRP) which chart the agency's long-range basic national research plans and how these link with the missions, goals and programs of the USDA. Each NRP includes research objectives, potential benefits and costs for conducting the proposed research.

A national coordinator from the National Program Staff (about 40 senior scientists, each of whom is recognized as a national and international authority in his field of science) is assigned for each NRP or SRP. He serves as a team leader of research technical advisors (scientists) from the field with whom he counsels regularly, in concert with line managers. The National Program Staff scientists are held accountable for integrating the agency's broad array of 67 NRP's and eight SRP's into a smaller, more easily manageable number of significant programs and objectives which relate to department programs. Furthermore, they function as an effective liaison between the scientists and top line management of SEA/AR.

The 67 NRP's also serve as the focal point for the approximately 1400 SEA/AR Work Reporting Units (WRU's), each of which describes the research under one NRP at a given laboratory or work location. Further, each WRU serves as the basic unit for fund accounting. The 1400 WRU's comprise approximately 3200 research projects, or Current Research Information System (CRIS) units, each with specific research endeavors relating to clearly delineated scientific objectives. Each project is planned to be completed within three to five years. This is significant for research planning in that approximately one-fourth of the 3200 research projects are completed in a given year, thus freeing resources for possible allocation to new high priority research problems. The SEA/AR reviews and periodic updates of CRIS units give cognizance to the inputs from regional planning committees.

Annually each scientist responsible for a WRU develops an annual report and plans for appropriate line managers and National Research Program coordinators. These reports are used by the National Research Program coordinator to develop a summary national report. This, along with periodic site visits made and national program reviews, facilitates tracking all research, assessing progress and relating results to closely allied research of other scientists (federal, state and private), keeping abreast of developing technologies and sensing importance of newly developing research problems.

National Program Coordinators are usually active in professional scientific societies and in long-standing work planning conferences involving scientists from the federal, state and private sectors. At such meetings and conferences high priority research problems and on-going research are discussed in open and objective manners. This provides an excellent opportunity for joint planning to assure that all researchable facets will be pursued with an absolute minimum of similar effort (in some instances similar studies at several diverse locations are important to determine environmental effects of widely differing climates and soils). As a result, the community of scientists feel reassured of pursuing specific lines of research which, in fact, contribute to carefully planned, broad regional and national objectives.

While the work group has no specific recommendations for how to do this, there is merit in examining the rationale for possibly combining CRIS and MAPS into one classification system. The CRIS system is used as the basic input for state, federal and some private agricultural research organizations, but the method of aggregation for planning and management purposes differs among the major performers. A modified system of classification could be beneficial.

C. Other Classification Systems

There are several systems used for classification of science in general including agricultural research. They could possibly be used for management purposes, but they have not except for sources of information to scientists and managers.

One of the information systems is the Smithsonian Science Information Exchange, Inc. (SSIE). It contains project information gathered from more than 1300 state, federal and private organizations, and currently contains descriptions of more than 300,000 on-going or recently completed research projects. The system may be particularly useful as a data base, for each research information package includes the following information:

1. Project title
2. Technical summary
3. Performing organization name and address
4. Principal and co-investigator names
5. Supporting organization, name, address and grant number
6. Level of funding

Another means of classifying research is the system used by libraries. Scientists throughout the world have one trait in common--they review the scientific literature to learn what research has been published on the subject of interest to them. Computerized information retrieval systems are becoming available world-wide, and agricultural research scientists will use them to obtain information to avoid duplication of effort, to plan future studies, and to improve research management in general. Information knows no geographic boundaries, and it is invaluable to scientists in planning what further research is needed to fill gaps in knowledge.

The Zero Base Budget (ZBB) method of budget preparation currently used by the Executive Branch has resulted in a classification system used for budget preparation, and to a certain extent, for management purposes. Decision units are developed to be used to assess current and future needed levels of activity in research, extension and higher education in the USDA. The information needed, however, is based on information sought for this specific purpose, and from EMIS, CRIS and MAPS reports. Therefore, the Decision Units, which will vary from year to year, would not serve as a useful classification system for long-range management purposes.

Each research organization, whether state, federal or private, has a subtle inclination to develop its own unique classification system for management purposes. Because of this, there are undoubtedly numerous unofficial, unpublished classification systems that have been used to meet the specific needs of research units. One such system would be to classify research by commodity. State Agricultural Experiment Station directors, for instance, pay considerable attention to the allocation of resources for the major commodities grown and/or processed in their states. They also will tend to take into consideration the disciplines involved in solving problems when they allocate resources. These are both accommodated by the CRIS system, though, so they do not really represent a different classification system for management.

When a topic, such as Human Nutrition or Post-Harvest Technology becomes a high priority (or very low priority) area for funding by the federal government, special studies may be needed to obtain the information needed for budget allocations and other management decisions.

This was the case when an ad hoc committee on human nutrition was formed by the Joint Council on Food and Agricultural Sciences (1980). They found available sources of information to be inadequate, so they developed their own classification system to classify human nutrition research programs. They used 12 major categories based on needs for sound scientific knowledge from which to make dietary recommendations and guide action programs. The categories were as follows:

1. Nutrient requirements - encompasses elements and compounds identified as essential to man and that man does not synthesize in amounts adequate to maintain body functions and health.

2. Nutrient metabolism and functions - to elucidate the role or function of nutrients in man, their essentiality, digestion and absorption.

3. Diet/health relationships - to determine the effects of total diets, individual foods and food constituents upon the health of man.

4. Nutrition and human development and performance - relationship of diet to physical and physiological development, performance and changes throughout life.

5. Nutrition monitoring and surveillance - encompasses the several approaches--economic, epidemiological, biochemical and clinical--that are used to estimate nutritional adequacy of the food supply, diets and intake.

6. Nutrition and behavior - encompasses both the effect of diet and food constituents on emotional behavior and the effects of environment, sociocultural and psychological factors on diet quality.

7. Studies related to intervention programs - on the impact of programs having as a goal improving the diets of high risk groups by economic, educational or other means.

8. Nutrition and dietary guidance - covers the development of information intervention programs whose primary objective is to improve the nutritional quality of diets.

9. Nutrition information development and delivery - combines research on developing and evaluating the strategies and systems used to deliver nutrition information with evaluation of those programs.

10. Nutrition education and training - the development of new concepts for teaching nutrition as well as development of curricula for nutrition education and training in schools and universities.

11. Food composition - major focus on the nutrient content of food and food products.

12. Food delivery systems with a focus on diets, nutrition and health - on improving the nutritional quality of foods through changes in production, processing, marketing and food service systems as well as the development of food products to meet special and unusual nutritional needs.

Other factors used in classifying human nutrition research included several biological, economic and health factors. Projects were classed for age, sex, pregnancy and lactation, ethnic group, income level, urbanization, place of birth, nutrients studied, health factor and research model system. These could be accommodated by CRIS, but evidently have not been in the past.

VI. ADVANTAGES AND DISADVANTAGES FOR MANAGEMENT PURPOSES OF DIFFERENTIATING RESEARCH PROBLEMS AS INTERNATIONAL, NATIONAL, REGIONAL, STATE OR LOCAL

A. State Agencies

The advantage, for management purposes, of differentiating research problems as international, national, state or local is accountability for funds or support from a source that is restrictive. It may be used in a general way to arbitrarily distinguish between the major roles to be assumed by state research agencies as compared to federal agencies such as SEA/AR. State-appropriated funds are often intended to be used to support research that would have a direct bearing on solving local and state problems. Federal formula funds (ex. Hatch) appropriated to states are used primarily to solve problems of that state or region, but collectively, in coordination with SEA/AR and other groups, they contribute to the solution of problems of national and international concern.

If funds are made available to state agencies from the State Department Agency for International Development (AID) to conduct research in Nigeria on peanut production, it would be logical to classify it, for management purposes and for proper accountability, as international research. The same type of research, however, could just as readily be classified as state or local. In Georgia, for example, peanut production is an important enterprise. Georgia's agricultural leaders and legislators would support research on this commodity if they felt that it would benefit Georgia's citizens. If it is classified as international and is intended primarily to develop a competitive enterprise in a foreign country, there is still a possibility that local state support would be provided from a humanitarian motivation. However, the support is unlikely to be as great as it would be if local citizens were to be the initial primary beneficiaries.

The above example applies primarily to the State Agricultural Experiment Stations and Eligible 1890 Institutions and to the few non-land-grant universities that conduct agricultural research. One advantage of classifying research as regional or national is to increase the cooperation of scientists in other states and other research units in more rapidly finding solutions to complex problems. Many problems are too large and complex for sufficient resources to be available at only one institution or within a state to solve them in a reasonable length of time. Long-term animal and plant breeding programs are among research problems that could be classified in this category, and they may advantageously be classified as regional, national or international. Clearly defined goals and specific plans, with agreed-upon division of duties and responsibilities, are essential for cooperative ventures of this type to be successful. The professional welfare of the scientists involved in such endeavors may be jeopardized if the regional or interregional projects are not well planned and managed.

Motivation of some scientists to be of service to mankind in general would be another advantage of classifying research as international, national or regional that would have potential broad application. Other scientists, though, may prefer to see more immediate application of the results of their research, and would prefer to work on problems classified as local or state. They may have the satisfaction of seeing the results of their research put into practice within their states or regions. Professional recognition and promotion in academic rank in some state universities are related to national and international accomplishments, and they may be difficult to obtain if research is limited to a specific, "local" commodity.

The major disadvantage of classifying research problems as international, national, regional, state or local is that such definitions are not sufficiently precise and permanent to be used effectively for management purposes. A problem classified as local may become regional, national or international in scope if it is not solved soon. If a problem is solved soon enough, and is on a commodity that is produced only in a limited area, it could be logically classified as local. However, once sufficient information is available and the economic incentive is great enough for someone to attempt to adopt the enterprise in another area of the world, the same problem could become national or international. This system of research problem differentiation is too imprecise to use by state research managers for management purposes, except in very general terms to assist them in accounting for the use of restrictive funds.

B. Federal Agencies

USDA is the lead federal agency with the responsibility for agricultural research. However, some agricultural research is financed or conducted by the National Science Foundation, Department of Energy, Environmental Protection Agency, Health and Welfare Department and Department of Defense.

The advantage for management purposes of differentiating research problems as international, national, state and local from a federal standpoint is to reach an understanding with cooperators as to who will accept the primary responsibility for finding the solution to a research problem. SEA/AR, for instance, has the primary responsibility for conducting research that is national or regional in scope. To do this, it is necessary to define, as precisely as possible, what research is considered to be regional, national or international.

For example, let us assume that the boll weevil has spread across the southeastern cotton belt and is seriously damaging cotton in 12 states. Let us assume that all 12 states, SEA/AR and ESCS have various research programs related to the control of the boll weevil. While the cotton in each state is being affected, and thus to that state it is a state research problem, it is, by definition, a regional problem. Therefore, if a coordinated regional research thrust is initiated, it would be highly desirable for SEA/AR to furnish a scientist to coordinate the regional research effort, assuming that SEA/AR had employed, or could employ, a competent scientist who was an effective leader. The SEA/AR scientist would normally have less problems travelling anywhere in the region at any time needed to do the coordination. SEA/AR research leaders of programs concentrate on research principles that could apply across the region. State scientists should be sure the technology developed applies to the ecological conditions found in their state.

Another example is control of the citrus black fly. SEA/AR had an active research program on the control of the citrus black fly cooperative with the Texas Agricultural Experiment Station of Texas A&M University because the citrus black fly was damaging citrus in the southern part of Texas and Mexico and thus was an international problem. Later, the citrus black fly was discovered in south Florida. SEA/AR scientists immediately increased the production of parasites found effective in the control of the citrus black fly in Texas and furnished them to the Animal and Plant Health Inspection Service (APHIS) of the USDA and the Florida Department of Agriculture for tests and worked with the two agencies on measurements of the effect of control. The parasites were very effective in the control of the citrus black fly.

The disadvantages for management purposes of differentiating research problems is: (1) many problems fall in the intermediate area; (2) solution to problems are conceived by scientists and often a scientist who might not have the problem in his/her state or sphere of responsibility will have the best ideas for its solution; (3) science knows no boundaries; therefore, it is difficult to limit scientific thought to a classification system; and (4) sometimes having a classification system will stifle creativity.

C. International

The U.S. Agency for International Development (AID) is within the Department of State, and in carrying out its assistance program functions in less developed countries has a long-standing, active program on technical assistance, research and rural development. These programs involve need for scientific and technical assistance in agriculture which AID frequently provides through agreements from the agricultural scientific community of the land-grant universities, non-land-grant universities and the U.S. Department of Agriculture. Such agreements assure that AID funds are provided to cover the costs of such scientists and advisors assigned to AID on a temporary duty (TDY) or through a Participating Agency Service Agreement (PASA). These U.S. scientists and advisors are assigned to a developing country to provide the prescribed assistance while at the same time training people in the country usually working in an apprenticeship arrangement.

In the early part of the 20th century successful industrialists in the U.S. established trust funds to be used for specified worthy causes. The most notable of these, in terms of assistance to agriculture, include the Rockefeller, Ford and Kellogg Foundations. The usual arrangements are for interest accruing from these trust funds to be used for endowments for carrying out worthy causes. The three foundations became very active beginning in the 1940s in establishing agricultural development programs in foreign countries. The first such significant program was the one begun by the Rockefeller Foundation in Mexico in 1942. At the outset a given foundation tended to operate independently; later, they cooperated in carrying forward on a given activity, and finally, because of mushrooming need for more programs and increased costs, they invited and solicited the help of the United States and various international and national governmental agencies. Today, the principal international centers and programs are funded under the aegis of the Consultative Group on International Agricultural Research (CGIAR).

Consultative Group on International Agricultural Research (CGIAR)

Current funding of principal international centers and programs (earlier funded by foundations) is provided by members of the CGIAR. This is the coordinating committee of donor organizations, including agencies of national governments, foundations and international organizations jointly sponsored by the World Bank, FAO and the United Nations Development Program (UNDP). Total funding of about $80 million in 1977 through CGIAR was expected to reach $120 million by 1980, with the view that the U.S. should continue providing about 25 percent of the total funding for international centers and programs sponsored by CGIAR.

The advantages and disadvantages for management purposes of diferentiating research problems of international programs may not be as clear cut for domestic programs. However, when considering the functions and interests of the principle organized thrusts of AID, the Foundations, and CGIAR, some possible advantages might include: (1) opportunity for a coordinated thrust on highest priority needs of third world countries, (2) clearer delineation of the kinds and quality of expertise needed to effectively implement planned programs, (3) better planning and coordination of levels of cooperative effort among federal and state agencies, and (4) a clearer understanding of need for an equitable mechanism for shared sustained funding of international programs. Among likely disadvantages would be: (1) competition of time required for participative planning of international programs with that needed to effectively carry out the mandates of primary responsibilities for managing domestic programs (this is becoming critical because of ever-tightening personnel ceilings), and (2) inability of many domestic agencies to provide continuity of persons to participate in specific third world country programs.

VII. CRITERIA FOR DIFFERENTIATING PRESENT PROBLEMS AS INTERNATIONAL, NATIONAL, REGIONAL OR LOCAL

The criteria for differentiating problems as local, regional, national or international include the geographical extent and scope of the problem, the restrictions on the funds used to support the research, the probable transferability of the results of the research, the primary beneficiaries of results and the regulatory and statutory needs.

The scope of a problem may change due to a number of biological, physical, economic, sociological or political factors. For instance, the problem with fire ants was local when they were first imported into Florida. As they multiplied and moved north they became a regional problem. Control of the insect with a non-biodegradable pesticide, "Mirex", caught the attention of the general public, and national environmental groups opposed aerial application of Mirex. This political involvement makes the problem national. Since the fire ant was imported from South America, studies are being conducted by American scientists there to assist in control of its spread in the U.S., as well as other places in the world. Thus, this problem once classified as local is now international in nature.

The primary beneficiaries of results of agricultural research are consumers. Transportation and marketing of agricultural products make even products grown in one locality available to consumers throughout the nation and the world. Even highly perishable products may be processed and transported for long distances, so this criterion is difficult to use.

The transferability of benefits of research conducted in one state or location to another state is one reason given by Ruttan (1978) for under investment in agricultural research. Research that is paid for by one state can be expected to have an impact on productivity of growth in other states (Ziemer, et al., 1981). This geographic "spillover" (see Figure 4 in Appendix) effect limits the incentive of individual states to invest in research, and is another justification for federal support of what may appear to be state or local research.

Garren and White (1980) developed an analytical framework which was designed to determine the efficient allocation of research funds among the different research areas in light of externalities such as spill-outs and spill-ins. They also concluded that more effort may be required by the federal government to encourage states to conduct research that would benefit society in general.

One of the limiting factors in conducting research is availability of funds and facilities. A survey of agricultural scientists throughout the United States (Busch, Lacy and Sachs, 1980) indicated that availability of research facilities and adequate funding were among the most important criteria in their choice of research problems. Thus, if a unique piece of equipment was required, and funds were available at a specific location to support research, the research problem could be classified as local, state, regional or national, depending on the sponsor.

Federal and State Regulatory and Statutory Needs

Federal and state governments have enacted many statutes to protect citizens, industries and the environment. Statutes enacted normally assign responsibility for the legislated functions to appropriate agencies to promulgate and carry out the needed regulations. In the case of federal laws, the criteria for the regulations applying are that generally the commodity, issue, resource or problem being regulated impacts on the national border or transcends the boundaries of two or more states. Exceptions would be federal regulations to contain or eradicate an exotic or new pest discovered in an isolated locality. Conversely, state regulatory laws apply only within the boundary of the state in question. In this case, the State Agricultural Experiment Station administered by SEA/CR would have primary responsibility for conducting the research.

There are many federal regulatory programs which impact nationally on agriculture and require constant updating of research technology to assure creditable regulations. SEA/AR is the USDA research unit that would have the primary responsibility to conduct research to assist the regulatory agency (see SEA/AR Mission Statement in Appendix). The most important of these in the USDA will be identified by the agency having primary responsibility for administering the law.

- Agricultural Marketing Service (AMS). The regulatory programs assigned to AMS are designed collectively to protect producers, handlers and consumers of agricultural commodities from financial loss or personal injury resulting from careless, deceptive or fraudulent marketing practices. The Packers and Stockyards Act of 1921 encourages free and open competition in marketing of livestock, meat and poultry, and many meat and poultry products, and prohibits certain practices which inhibit competition. Other AMS regulatory programs encourage fair trading practices in marketing fruits and vegetables; require truth-in-seed labeling and advertising (The Federal Seed Act), involve enforcement of the Plant Variety Protection Act; cover the licensing, bonding and examination of warehouse operations of agricultural products and commodities owned by government, and protect farmers' rights to organize cooperatives.

- Animal Plant Health Inspection Services (APHIS). APHIS was established to conduct regulatory and control programs for protecting and improving animal and plant health for the benefit of man and his environment. In cooperation with state governments, the service administers federal laws (the first such law was the Plant Quarantine Act of 1912) and regulations pertaining to animal and plant health and quarantines, noxious weeds, humane treatment of animals and the control and eradication of pests and diseases. Since pests and disease organisms often move with air currents, they readily spread across national borders. For this reason, several eradication and control programs undertaken by APHIS are cooperative with foreign governments.

- Federal Grain Inspection Service (FGIS). The FGIS is responsible for establishing official U.S. standards for food and feed grains and to assure their integrity in the inspection, grading, weighing and handling of American grain entering channels of interstate and international trade.

- Office of Transportation (OT). The OT has delegated authority to represent USDA on government-wide regulatory activities to assist in obtaining equitable transportation facilities, rates, charges, tariffs, practices and services for agricultural products and farm supplies by making complaint or petition to the Interstate Commerce Commission, the Federal Maritime Commission, the Civil Aeronautics Board or other federal or state transportation regulatory bodies.

- Food Safety and Quality Service (FSQS). The FSQS has the responsibility for the inspection required by law and truth in labeling for all meat, poultry and related products processed by plants shipping in interstate and foreign commerce. The intent of this activity is to assure the consumer that foods are safe, wholesome, and nutritious, and that they are uniformly and honestly labeled.

VIII. OTHER MEANS OF DIFFERENTIATION OF RESEARCH PROBLEMS

Differentiating research problems by soil types may be useful in certain types of research problems and useless in many other types of research problems. In problems relating to soil erosion, water management, certain soil-borne pest and tillage problems the soil type classification system would be quite meaningful. In crop processing it would be useless. The soil type classification would have little use in fixing responsibility for solving research problems by industry, state or federal sectors.

The same as above would apply to a classification system involving unique climates. This classification would be useful for such research problems as determining water management systems for various crops in various unique climates, but would be of little value in fixing responsibility for solving the research problem.

While pest problems--namely, insects, diseases and nematodes of plants and animals, and of weeds which impact on crop culture and animal performance--vary by species in scope and seriousness, there is need for extensive, continuing research on the biology, control and eradication of pests. The magnitude and dynamics of such research required can best be appreciated when recognizing there are upwards of 16,000 ubiquitous species of pests which are a constant threat to U.S. agriculture. These break down as approximately 10,000 species of insects (600 requiring annual control measures, 1,600 diseases, 1,500 nematodes and 1,800 weeds of concern on crops, and approximately 300 species of insects, ticks and mites, and several hundred species of endemically established diseases and internal parasites, and 15 species of exotic diseases of domesticated livestock and poultry. Some of the animal insects and diseases can also be harmful to man. Within the entire pest complex there is virtual assurance that many, but likely, different species of these will occur in epidemic proportions in one or more localities and regions of the U.S. in any given year. This danger is further complicated by the biological nature of insects and disease organisms to give rise spontaneously to new biotypes, forms and races that may be equally or more destructive and likely not as susceptible to reasonably satisfactory control measures used against earlier forms.

The magnitude of pest control and eradication research far exceeds what can be conducted by all agencies in the public and private sector. Further, with mushrooming concerns over environmental and product pollution, and human health from chemicals for pest control, the need for expanded and more effective pest management programs with minimum or no chemicals required is critical. An important component of envisioned, effective pest management programs is meaningful biological control through availability of a wider array and more effective use of parasites, predators and pathogens and viruses for control of economically damaging pests. (The first success for the U.S. was in 1888-89 with the introduction, from Australia, of the vedalia beetle for control of the citrus scale insect.) This means stepping up collection and evaluation of these control organisms in world centers of origin of the primary host crop plant most vulnerable to damage by species of pests that are continuing threats to U.S. agriculture.

When considering criteria essential to timely response in effectively coping with the dynamics of pest problems--particularly quick, unanticipated program changes necessary to research emerging high priority problems of the moment, and the critical mass of multidiscipline scientists and magnitude of funding resources required for accomplishing major shifts--it becomes apparent that some research institutions have quicker response flexibility than others. Federal research units, such as SEA/AR likely could, and should, assume certain international and national responsibilities. The SEA/AR is equipped to manage and staff foreign laboratories for control research of exotic pests, and collecting and evaluating parasites and predators as potential biological control agents. SEA/AR is also prepared to meet federal quarantine regulations for introduction of potential biological control agents. Domestically, SEA/AR is charged with responsibility for accommodating the research and technology needs for regulatory agencies of the USDA to carry out their mandated control and eradication programs. The states are best prepared to handle research on problems of limited geographic concern, and they cooperate with SEA/AR and other scientists in solving regional, national and international problems. Newly emerging high priority research needs on endemic pests of widespread geographic concern can be shared, as mutually agreed, among federal and state institutions in the hope of minimizing losses from resource reallocation from ongoing research not yet advanced to logical termination.

An example of a location-specific problem is when there is an accident resulting in contamination of an area with a toxic compound such as PCB (polychlorobiphenyl), mercury or other material. It is indeed a location-specific, local problem, and if research has not already been conducted that offers some solution, research could be initiated. Usually there is some information available from research already underway on related topics that will assist scientists in undertaking the research. There have been several incidents in which PCBs have been found in livestock and poultry feed. Research with these toxic compounds has shown that they reduce hatchability of eggs, lower feed efficiency and adversely affect animal performance. A microorganism that breaks down PCBs was recently discovered by a State Agricultural Experiment Station food scientist, and this approach may be useful in solving some of the location-specific problems.

Research is sometimes classified as basic, applied or development. The definitions used by the National Science Foundation (NSF) are:

- Basic research is directed toward increases of knowledge in science where the investigator is concerned primarily with gaining a fuller knowledge or understanding of the subject under study.

- Applied research is directed toward practical application of knowledge. It covers research where the investigator is primarily interested in a practical use of the knowledge or understanding for the purpose of meeting a recognized need.

- Development is the systematic use of scientific knowledge and understanding gained from research directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes. It excludes quality control, routine product testing and production.

The major advantage of using these criteria to classify research is for funding by federal agencies such as NSF. The USDA has become more aware in recent years of the need for more basic research, and such a classification system enables them to allocate funds in this manner across disciplines and political boundaries. Most USDA research is mission-oriented, and there are so many problems of agricultural production, harvesting, conservation, processing, marketing and transportation that research classified as "applied" will continue to be stressed by state and federal leaders.

Time constraints and public pressures usually come for development and applied research rather than for basic. However, once the research needs are classified as basic, applied or development by a funding agency, scientists respond accordingly.

A disadvantage to using these criteria is one of semantics. What one person perceives as being basic research is viewed by another equally qualified person as being applied. Research is a continuum rather than being clearly defined. Attempts to draw a line of demarcation between basic and applied research are illusory (Pino, 1980). Pasteur once remarked "there is no pure science or applied science--only science and the application of science." More important is that the research, whether basic, applied or development, can have an ultimate beneficial effect to mankind.

Another means of differentiating research programs for management purposes is the scope of work or magnitude. The inputs required, including personnel, special equipment, funds and special conditions sometimes dictate where research will be conducted and how it is classified. The advantages and disadvantages of using scope of work are essentially the same as for a location-specific classification system.

Other possible systems would be output destination, such as who the primary beneficiaries of research are, and the urgency of the problem. If an emergency arises that will affect several states, the combined state and federal resources are usually reallocated to cope with it. This was the case with the southern corn blight in 1970, and with the severe aflatoxin problem in the southeast in 1977.

Research classification by political stratification is another possibility. Agencies that provide funds for agricultural research require accountability, and in some instances they provide specific guidelines for how funds are to be spent. States vary in the extent to which funds are earmarked for agricultural research by the State Agricultural Experiment Stations, Eligible 1890 Institutions and non-land-grant institutions. The state executive, legislative and judicial branches may all become involved. Usually the governor of a state prepares a budget, and this is submitted to the legislative branch for approval. In some instances, specific recommendations are made as to which projects, including specific commodities, building programs, equipment, personnel and other items, are to be funded. In other states, less specific requirements are expressed, but accountability is still enforced. Until recently, the judicial branch rarely became involved in program decisions. However, a court case in California involving the use of funds to support research on mechanization indicates that the judicial branch can exert an effect on specific agricultural research programs. The judicial branch also exerts considerable influence on personnel management, particularly as regards equal opportunity, affirmative action plans in all publicly supported research organizations.

Political stratifications at the federal level are many, and can best be grouped under three branches of government--namely, executive, legislative and judicial.

- Executive. All federal research agencies are administered within the executive branch of government. This means that all budget requests, fund allocations and mandated directives must be cleared through and have the approval of appropriate administrative echelons in the executive, including the Office of Management and Budget, and the Secretary of the Department of Agriculture. During the 12, or more, most recent years there have been ever-tightening directives for further reducing the number of federal employees (personnel ceiling constraints) and tendencies to make drastic curtailments of funds expended for domestic and international travel. This has permitted employment of only relatively small numbers of young, newly trained scientists with the resultant substantial net annual losses of total employees, and an alarming increase in average age of the staff of scientists. This continues to impact critically on having available a cadre of experienced young scientists to fill key positions vacated by retirements, resignations or other causes. Also, restrictions on travel preclude ideal servicing and observation of research plots, which often makes it difficult to understand or explain end results of the study in question. Moreover, the limited travel precludes research supervisors and managers from making the site visits and personal inputs required for conducting and managing a first-rate, highly credible research program and agency.

Within static or eroding budgets and tight personnel ceiling constraints as experienced in most years since 1966, it is becoming progressively more difficult to mount new programs as mandated by the executive and legislative branches. Adjustments made usually cause serious imbalances because of premature termination of unfinished high priority research, improper use of scientist talents and continuing uneasiness over where and how much of the next program cut might be accomplished. This is impacting on morale of scientists and support help without any evidence that scientific judgment has merit in decision making within a structure where political survival appears to take precedence over the most critical technology needs for the country as a whole.

Other disadvantages of political stratifications of the executive branch include: (1) the policy of routinely precluding annual budget increases to cover the cost of inflation and for capital improvement; (2) the mandated requirement for contractors bidding on scheduled construction of federal buildings to meet the local labor rates (this often increases construction costs upwards of 50 percent); and (3) GSA requirements which preclude purchasing at oft time lower prices on the open market than available through GSA schedules.

- Legislative. The Senate and House subcommittees for agricultural appropriations are generally more objective than the executive in avoiding sudden, unjustified program changes. Conversely, because of local voter reaction, it is difficult to get Congressional approval to close a work location when the research program in question has reached reasonable conclusion. Politically motivated congressional mandates to continue research at such locations often result in poor continuing investment of resources when they would do the country more good by shifting to higher priority needs of other locations.

Another political stratification of the legislative branch concerns facilities. Frequently, as members of Congress advance to responsible positions on key committees, they use this power to justify the need for appropriations to construct a facility within their district or state. Within the SEA/AR there are 145 research centers, laboratories and field stations, about one-half of which were built through initiatives of Congress. Most of these facilities are excellent and at one time were, and many still are, involved in extremely important and high priority worthwhile work. However, once the laboratory mission is completed and there is little opportunity to use the facility for other research, it is difficult to close and dispose. There are several instances where administrative and scientific management has proposed closure (three times for some over periods of 10 to 15 years) but with no success in getting the needed legislative approval.

An untenable problem for Congress is to realize the difficulties encountered in meaningful implementation of a new program when the responsible agency is saddled with reduced personnel ceilings as mandated by the executive branch.

- Judicial. There are a number of litigations concerning continued registration and use of specific agricultural pesticides. Such litigations seriously hamper further research and development of new chemicals for pest control.

Several years ago one of the public interest environmental groups sued the USDA for its application to issue a limited exclusive license to manufacture limited quantities (annual U.S. sales volume estimated not to exceed $100,000) of an antibiotic for which USDA has a patented use, but for which the original antibiotic patent had expired. The new use is to apply to citrus for enhancement of fruit abscission as an aid to mechanical harvesting. While the judge refused to hear the case because of its failure to directly impact on the environmental group, it has placed a serious constraint on getting approval of the limited exclusive license concept and on interesting drug manufacturers to produce the limited quantities of the specific antibiotic important to citrus growers and in turn more reasonably priced citrus products to the consumer.

The private sector has been active in pursuit of applied research which yields a saleable product protected by proprietary rights and has enough sales volume potential to return a reasonable profit. Significant examples of success stories for the industry which have benefitted agriculture tremendously include hybrid corn, agricultural chemicals, vegetable seeds, and in more recent times, following enactment of the Plant Variety Protection Act, breeding new varieties of most major field crops.

Political stratifications which seriously impede industry include an array of regulations impacting on products developed and sold. For example, the Environmental Protection Agency, in carrying out its functions, imposes contaminant and pollution tolerance so rigid that the increased costs of approval and use of pest control chemicals are prohibitively high in many cases. This results from obsolete legislation of the Federal Insecticide/Fungicide/Rodenticide Act (FIFRA), which mandated zero tolerances for carcinogenic substances at a time that the best scientific apparatus detected only parts per million. Today, detections can be accurately determined as parts per trillion.

Further, feeding trials using small laboratory animals permit ingestion of suspect materials upwards of 100 times the normal intake rate. This problem is further unrealistically complicated by permitting interpolation of results from such small animal feeding trials to have an effect on humans.

Another type of constraint is the build-up of regulations developed by regulatory agencies. While most regulations probably contribute to the safety and health of people, there is serious question whether the benefit of many to society is worth the added cost incurred by the producer and finally passed on to the consumer.

IX. PROBLEMS OF AGGREGATION OF INDIVIDUAL RESEARCH ACTIVITIES

It is ironic that identification of research on location-specific agricultural commodities or programs becomes so cumbersome that research managers insist on aggregating into larger units. This is cause for losing the detail needed to fully describe the total research and to document program changes made within a given aggregation. Some specific examples include difficulty of documenting a true shift of resources from research on crown rust of oats to a study on a new race of oat stem rust when both studies come under the aggregation of research on diseases of oats. Other examples include the crops of guar and crambe.

The only federal guar crop culture and variety development research in the country is the SEA/AR one-man program at Texas Research and Education Center at Vernon, Texas. Similar problems prevail for the SEA/AR program on crambe. Research identity of these two crops is lost because of need to aggregate research thrusts into a reasonably small number of manageable research activities. Hence, guar and crambe studies are aggregated with other oil seed crops, thereby giving them extremely low focus as compared with oilseeds such as soybean and sunflower. This creates problems for the researcher and commodity interest group because of the tendency for research managers to favor for increased funding those crops considered to have major importance in the aggregated national research program in oilseed crops.

At any time there are a number of crops that are relatively small in acreage or new to U.S. agriculture. Some of these are classified as either specialty or minor crops despite the fact they represent an important segment of U.S. agriculture, both established and developing. Crops currently aggregated under minor crops include crambe, guar, hops, mint, kenaf, lentils, datepalm and filbert. While none occupy a large acreage, there is sufficient interest and agricultural potential that grower groups plead the need for federal research to solve some of the more serious cultural and marketing problems. In some instances most of the organized research on these crops may be by SEA/AR, and politically it is difficult to get concurrence from the legislative branch of government to reduce, much less to terminate, such research. There is reasonably good justification of this when recalling that major crops in today's agriculture were but minor not too many years ago. Examples of this include soybeans and sunflower. Also there are those specialty crops which never have been, nor likely will be, grown on sizeable acreages. Examples of this are buckwheat and filberts with the only research on buckwheat being conducted by the Pennsylvania Agricultural Experiment Station and filberts research by the Oregon Agriculture Experiment Station with SEA/AR.

Minor livestock and poultry species include goats, rabbits and guinea fowl. While investment of research funds and manpower to develop production and management technology for these species is highly questionable, there is realization of an obligation to that segment of society which desires to get involved in part-time or small farm operations complete with home processing and marketing via road-side stands or through special interest outlets.

X. DETERMINE THE APPROPRIATE AND/OR COMBINATION OF METHODS AND DEMONSTRATE THEIR APPLICABILITY ON ONE OR MORE RESEARCH PROBLEMS

Earlier sections of this background paper covered in detail various approaches and criteria for differentiating research problems for planning and management purposes. The intent of this portion of the paper is to demonstrate how one or more combination of these methods might be applied toward implementing and pursuing research on specific problems.

A. Production

- Livestock and Poultry. Research livestock and poultry production has lead to increased efficiency of feed utilization, more disease resistance and improved quality. Beef cattle have increased in liveweight marketed per breeding female from 310 pounds in 1950 to 482 pounds in 1975. Milk production per breeding dairy cow increased from 5,313 pounds to 10,500 pounds during this period. Pigs produced in 1975 had 5.7 pounds less lard per 100 liveweight than in 1950, and the average time to produce a 220-pound pig decreased from 170 days to only 157 days. These advances were due to research conducted by state and federal scientists (CAST, 1980).

A regional research project on poultry involved several State Agricultural Experiment Stations and SEA/AR has lead to lines differing widely in growth rates, feed efficiency, resistance to aflatoxins and other characteristics. A SEA/AR scientist housed with State Agricultural Experiment Station scientists coordinates this regional research. It would be classified as regional, basic and applied, on poultry, with the aim of increasing biological efficiency. Research such as this has lead to increasing feed efficiency in broiler production from four pounds of feed to less than two pounds of feed to produce a pound of broiler. The time required to grow the birds to market weight has been reduced from over 12 weeks to less than seven weeks. Since beginning of the broiler industry, the time required to produce the broiler has been cut in half, the size of the broiler has increased by one-third and the amount of feed required has been decreased by 50 percent (CAST, 1980).

The CRIS classification for this regional poultry genetics research would be:

Goal III. Produce an adequate supply of farm and forest products at decreasing real production costs.

RPA 310. Reproductive performance of livestock, poultry and other animals.

Activity 5000. Improving biological efficiency of plants and animals.

Commodity 2900. Poultry.

Field of Science 0510. Animal genetics and breeding.

For regional and national planning purposes, this research would be grouped under RPG 4.00 Animals, and RP 4.03 Poultry. The SEA/AR National Research Program on poultry production would be classified for MAPS under NRP 20390. Individual scientists, though, would report their research using the CRIS reporting units, and they would be aggregated under WRU's, NRP's, etc., depending on the organization and level of administration using the information for management decisions.

- Field Crop Production. Wheat, the most important food grain in the U.S. and Canada, and second only to rice for the world, is vulnerable to a number of pests, including the diseases of bunt and loose smuts, and leaf, stem and strip rusts, and insects such as hessian fly, cereal leaf beetle and aphids. Adding to the pest problems are specific production problems associated with different geographic areas of production for the six major classes of wheat (soft red winter in Eastern U.S., hard red winter in the Great Plains States, hard red spring and durham wheats in the North Plains, white and club wheats in Western U.S. and the states of Michigan and New York) and the spontaneous and relatively frequent occurrence of new races of diseases and new biotypes of insects. The following history of varietal changes in one production area is typical for all classes of wheat grown in the U.S.:

> "A continued research effort is needed to grow wheat. In recent years the life expectancy of wheat varieties in the Pacific Northwest has been about five years. The variety Elgin was grown for six years before common bunt became destructive to it. Elmar replaced Elgin, but within five years it was compromised by another bunt race. Omar replaced Elmar in 1957 and comprised 47.2% of the wheat acreage by 1959. But Omar had to be replaced by Gaines in 1961 because of extreme stripe rust susceptability. In turn, Nugaines had replaced nearly half of the Gaines wheat by 1969. In Washington, increased wheat production between 1964 and 1970 came to over 150 million bushels and provided cash receipts in excess of $200 million at 1967 prices. Even so, current varieties have weaknesses--susceptibility to new races of diseases and lack of cold hardiness --and will have to be replaced soon if wheat is to remain productive, efficient, competitive in the area. Three new varieties were released in 1970 alone."
>
> ". . . most important, however, is that without the base of research in the Northwest over the years, no varieties would exist today to permit this region to compete in wheat production. Similar examples apply to almost every region, commodity and industry. Somehow, we take this steady flow of technology for granted. . . ."

With research problems reflected in the above, plus root rot disease (the best control is late fall planting which increases soil erosion problems of the palouse soils) small grain insects, wheat quality and farmer input-output costs it is apparent that a continuing multidiscipline effort is required by public agencies and the private sector. Scientific disciplines involved include plant pathologists, breeders, geneticists, physiologists, entomologists, soil scientists, agricultural engineers, cereal chemists, economists, and agronomists. Moreover, when considering the entire wheat industry there is need for long-range planning among federal, state and private research groups at the regional, interregional and national levels. Then as marketing problems arise, such as sprout damage and contamination with dwarf bunt spores being marketed in Japan and the Peoples Republic of China, respectively, the problems become international and involve additional expertise in marketing and quarantine.

Wheat production research would be classified under the CRIS system as follows:

Goal III. Produce an adequate supply of farm and forest products at decreasing real production costs.

RPA 307. Improvement of biological efficiency of field crops.

Activities 4900. Biology of plants and animals.
5000. Improving biolcgical efficiency of plants and animals.

Commodity 1700. Wheat.

Field of Science 0512. Plant genetics and breeding.

For regional and national planning purposes, this research would be grouped under Research Program Group RPG 3.00 Crops, and Research program 3.03 Wheat. The MAPS system would include this research under USDA program 26677, and NRP 20050 Breeding and Production - wheat, oats, barley, rice and other small grains. However, several other National Research Programs are involved in wheat research, including NRP 20750, NRP 20780, NRP 20740, NRP 20270, NRP 20080 and NRP 20280. It could be classified as international, national or regional. Basic as well as applied research is being conducted on this subject.

B. Crop and Livestock Protection

- Integrated Pest Management System. In 1964 the ARS, the Illinois Agricultural Experiment Station and industry planned a long-range cooperative study designed to develop technology for total farm weed control systems. The study involved the control of weeds through use of selected herbicides alone and in various combinations, and cultivation alone and in association with herbicides. The crops included the best corn hybrids and soybean and wheat varieties and a legume, all grown alone continuously and in various configurations of rotations. Full-time scientific disciplines included a weed scientist and an agronomist. Other disciplines involved, as needed, soil microbiologists, soil chemists, pesticide residue chemists, engineers, economists and wild life biologists. Financing in dollars or in kind toward the total effort involved federal funds from ARS, state funds from the University of Illinois and private funds.

Sixteen years of the study have been completed, and the first meaningful results are in the process of being developed into research manuscripts. Early and preliminary conclusions indicate that chemical weed control used alone and in combination with minimum post-emergence cultivation increased crop yields and net income and reduced the tillage requirements and labor inputs without damaging the chemical or physical properties of the soil without causing undesirable shifts in species of troublesome weeds and without upsetting the biological balance of the soil or the surrounding terrestrial environment. Of greater importance is the guidance gained from this study in planning broader pest management systems (weeds, insects and nematodes) in total farming systems as now being studied in New York, Georgia, Alabama and Mississippi.

Research conducted by the state, federal and industry scientists would be reported in the CRIS system as follows:

Goal II. Protect forests, crops and livestock from insects, diseases and other hazards.

RPA 209. Control of weeds and other hazards of field crops and range.

RPA 214. Protection of plants, animals and man from harmful effects of pollution.

Activity 4700. Protection against weeds and their control agents.
4830. Protection against pollutants.

Commodities:
1400 Corn
2300 Soybeans
1700 Wheat
6100 Weeds

Field of Science:
0714 Microbiology - soils
0212 Biology - environmental, systematic applied - plant
1528 Chemistry - soils
1920 Engineering - agriculture
2630 Economics

Special Category:
XPR Pollution-related

It would be classified under RPG 3.00 Crops, RP's 3.01 Corn, 3.03 Wheat and 3.06 Soybeans.

Several of the NRP's in the MAPS system would be involved, but particularly NRP 20280 Weed Control. In addition, NRP 20040, NRP 20050 and NRP 20790 would be appropriate.

- Integrated Screwworn Management Program for Livestock. Swamping native populations of screwworn flies with mass-produced sterilized male flies has proved highly effective in controlling screwworm flies. For a number of years the populations of this insect in the U.S. domesticated animal herds were contained at extremely low levels, thereby significantly reducing animal losses and increasing animal performance. Finally, this led to binational interest among U.S. and Mexican officials to extend the program to the entirety of Mexico and the United States. Momentary set-backs and delays encountered because of temporary political impediments, problems in maintaining competitive viability of sterilized flies, inability to adequately swamp wild fly populations with sterilized flies in difficult narrow valley mountain terrains and indequate funding have slowed the effective implementation of the program. Despite this, the program is moving ahead on a manageable and meaningful basis. The activity involves insect geneticists and entomologists who are expert in mass rearing and sterilization of insects, control officials, engineers, animal scientists and aircraft pilots.

This research is international in scope and involves research that could be classified as basic, applied and development. Scientists in the U.S. and Mexico cooperate. Under the CRIS system the research would be classified under:

Goal II. Protect forest crops and livestock from insects, diseases and other hazards.

RPA 210. Control of insects and external parasites affecting livestock, poultry and other animals.

Activity 4500. Protection against insects, mites, snails and slugs and their control agents.

Commodities:
3000 Beef Cattle
3300 Sheep

Field of Science:
0410 Entomology - animal
1010 Parasitology - animal
0513 Genetics - other
0210 Biology - environmental systematic applied - animal

Special Category:
PST 2 Target II, Improve means of non-pesticidal control

Research Program Group 4.00 Animals

Research Program RP 4.01 Beef
RP 4.04 Sheep

The MAPS system would classify this research under NRP No. 20480 Control of Insects Affecting Livestock, with cross-references to NRP 20250, NRP 20260 and several on livestock production.

C. Natural and Renewable Resources, Conservation Management and Use

Soil conservation problems are a major portion of the problems related to natural resource conservation. In this case, the Soil Conservation Service (SCS) is the action agency that works most closely with the farmers and ranchers to help them control soil erosion. Where the SCS has a specific need for research they expect SEA/AR to solve the problem since SEA/AR has responsibility for research to support federal action agencies. State Agricultural Experiment Station scientists throughout the United States also conduct research to solve soil erosion problems.

- Controlling Non-Point Source Pollution. Each year at least three billion tons of soil washed from fields and pastures pollute our streams and reservoirs. Three components combine to make up the total effect of pollution--namely, natural (precipitation, radiation and temperature), management (land use, cultural practices, plant nutrients and pesticides), and physical (geology, soil type and topography of the watershed). More than 50 SEA/AR scientists (soil scientists, physicists, engineers and agronomists) throughout the country, along with State Agricultural Experiment Station scientists, have been involved in providing data and development of a computer simulation model to predict the amount and effect of sediment from watershed runoff using the three components above. This model will assist in designing management and land use schemes that will minimize non-point source from farming and ranching. The model is now being tested in eight of the 20 land resource regions in the country.

Both the ARS MAPS system and the CRIS system are suitable for classifying this research. CRIS classification would be:

Goal I. Insure a stable and productive agriculture for the future through wise management of natural resources.

RPA 102. Soil, plant, water, nutrient relationships.

Activity 4300. Resource conservation

This research would be classified under the MAPS system primarily under NRP 20800 Erosion and Sedimentation. Research to conserve and manage agricultural water resources is classified primarily under NRP No. 20810. Several other National Research Programs are also applicable and are cross-referenced. They include NRP 20790 Air and Water Pollution, 20740 Irrigation and Drainage, 20760 Water Use Efficiency, 20110 Range Management and 20770 Strip Mine Reclamation.

Also, this research could be classified as a state or local, regional, national or international problem, and it involves basic as well as applied research in several fields of science.

D. Human Nutrition

Human nutrition research at the Colorado Agricultural Experiment Station has brought into question the belief that women need more iron than do men. One of the beliefs was that iron stores and serum iron in the women's body fluctuates, especially during the menstrual cycle, so women's diets should contain more iron than should men's. Studies of young women of college age during their menstrual cycle showed this not to be the case. Iron stores and serum iron does not fluctuate during the menstrual cycle. The indication is then that a nutritionally balanced diet, based on the recommended dietary allowance, probably supplies sufficient iron for women. The CRIS classification system for this research would be:

Goal VII. Protect consumer health and improve nutrition and well-being of the American people.

RPA 708. Human nutrition.

Activity 6300. Nutritional values, consumption patterns and eating quality of foods.
6320. Human nutrient requirements.

This research would be classified as national, and in the Joint Council system would be categorized Nutrient Requirements, subclassified for Sex and Physiological Function. This particular project was conducted using state and Hatch funds, but it could easily have been classified as regional or national. Under the new regional and national planning structure it would be classified under Research Program Group RPG 8.00. The MAPS system would classify this research under NRP No. 20910 Human Requirements for Nutrients.

Human nutrition studies in Tennessee showed that iron and magnesium were low in the diets of 119 pre-adolescent girls. Low hemoglobin levels, denoting iron deficiency, were increasingly prevalent with each subsequent year the girls were studied. The researchers pointed to the need for nutrition education, stressing the importance of including food sources rich in iron and other trace minerals. This research would be classified in the CRIS system under Goal VII, RPA 708, Activity 6300 and 7300, Evaluation of Public Programs, Policies and Services. Under the Joint Council (1980) system, it would be under Category 5, Nutrition Monitoring and Surveillance on Pre-adolescent Females, on Iron and Magnesium. It also could be classified as regional or national research.

Researchers from several universities in the North Central region (North Central Regional Project NC-945) are coordinating their studies of natural, modified and/or processed food fats to learn more about the basic metabolic and physiologic functions of these dietary components. They are identifying and delineating special components of food fats, such as state of saturation and unsaturation, cholesterol and lecithin, and specifying sites and functions in the body that are affected by food fats and food fat components. The CRIS system of classification is appropriate for management purposes, and would be under Goal VII, RPA 708, Activity 6300, 5410 Chemical and Physical Properties of Food, and 6360 Metabolism and function of nutrients. The MAPS system would classify it primarily under NRP No. 20910 Human Requirements for Nutrients, but NRP's 20900 and 20920 would also be applicable.

A Connecticut study on human nutrition improvement focuses on a segment of the population who are at risk because of elevated blood lipids. Research into the nature of the condition will help establish the degree of risk from a nutritional standpoint and form a basis for nutritional improvement. This is classified as regional, basic research, classified under CRIS as Goal VII, RPA 708, Activity 6300, Commodity 4000, Field of Science 0913 and RPF 8.00. The MAPS system would classify it under NRP 20910.

E. Post-Harvest Technology (PHT)

The classification of an area of research as post-harvest technology was done only in recent years. It encompasses the vast class of research to deal with problems encountered in processing, storage, distribution and utilization of agricultural commodities, including food, feed, fiber and fuels from agricultural materials. The title is new but the activities are not. USDA, state and industry scientists have been doing research in this area more than fifty years. If you compare food commodities available for purchase by consumers today with those available 50 years ago, the difference is remarkable. The variety, abundance and quality of products that are available to consumers today reflect the success of these studies.

Approximately two-thirds of the cost of food is attributed to processing, storage and distribution. The food, fiber and agriculturally produced fuel marketing system is critical to the well-being of the producer and consumer alike. Few individuals fully comprehend the dimensions and diversity of the food, fiber and agriculturally produced fuel system and its importance to human nutrition, as well as economics and social well-being.

In conducting post-harvest technology research, SEA: (1) addresses broadly beneficial, long-range and high risk research problems--particularly those that promote competition and innovation in the post-harvest system; (2) fulfills the scientific needs of governmental regulatory and action agencies; and (3) fills voids in the post-harvest research. The states are involved in processing of agricultural products grown within their states and post-harvest technology of interest to state regulatory agencies and producers and consumers of the state.

Under the CRIS system of classification most of the research problems related to post-harvest technology would be classified under the Research Problem Areas in Goals IV, V, VI and VII.

The problem with the CRIS classification is that it contains research other than post-harvest technology research. SEA/AR designed a system, based on MAPS, designed specifically for managing post-harvest research. It therefore is quite useful in managing post-harvest technology research.

> "Post-harvest technology involves conversion of raw farm commodities into safe, ready-to-eat food and useful products, and their delivery to the ultimate consumer. The role of PHT research is to improve the productivity and assure the safety of the food and fiber delivery system to the benefit of farmers, consumers and the national economy. Its aim is to reduce losses and lower the presently high cost of storing, processing, manufacturing, shipping and marketing

of farm products. Post-harvest research within the USDA is necessarily closely involved with the functions of processors and manufacturers, and its effect is to stimulate innovation, change and competition within the private sector.

Research in post-harvest technology (PHT) extends and complements the continuum of research beyond that concerned with our soil, water and air resources, and the production and protection of farm products. PHT research covers the complex marketing system from the farm to the consumer.

Research efforts are directed to the following areas: a) processing of fruits, vegetables, field crops, and animal products for food and animal products for food and feed uses, b) conversion and utilization of agricultural products and by-products for industrial and other nonfood uses, c) conversion of agricultural fibers to consumer products, d) storage, transportation and distribution of fruits, vegetables, seeds, nursery and floral products, field crops, livestock, meat and poultry products, e) protection of agricultural commodities and their products from losses to insects after harvest, f) quarantine treatments for prevention of movement in commerce of insect pests, g) development of new and improved products for export markets, h) transport and quality maintenance systems for overseas marketing, i) reducing hazards from chemical residues, additives, environmental contaminants, natural toxicants, and microorganisms and their toxins, and j) increasing the nutrient content and acceptability of foods through improved handling, storage, processing, formulation, and/or nutrient fortification."

The research in PHT for this assessment is described under twelve National Research Programs (NRP's). Activities covering the above areas may be summarized as follows:

NRP 20510: Technologies for Food and Feed Uses - Fruits and Vegetables

Involves the integration of studies on the quality and composition of fruits and vegetables, the nature and degree of change during production, harvesting, storage and processing, and the quality and yield of the processed product.

NRP 20520: Processing Technologies - Field Crops

Research problems involved in assuring the consumer an adequate supply of high quality, nutritious, safe and reasonably priced food and feed products from field crops and assuring the farmer a reasonable return for his crop.

NRP 20550: Technologies for Fiber Uses

Technologies involved with transforming natural fibers into consumer products.

NRP 20580: Technologies for Marketing - Fruits, Vegetables, Seeds, Nursery and Floral Products

Successful marketing of horticultural products requires an efficient system capable of providing high quality, nutritious and safe products to the consumer with adequate shelf life. Research under this program is conducted to increase the efficiency of marketing, and at the same time to reduce losses in harvesting, handling, storing and distribution. Present methods of handling fresh horticultural products from the farm through retail stores still are conducive to many losses.

NRP 20590: Technologies for Marketing Field Crops

Principal concerns during the movement of field crops through the market channels are losses due to deterioration of quality, nutritional changes, mechanical injury and pathological and entomological infestations.

NRP 20600: Technologies for Marketing Livestock and Animal Products

To increase efficiency, reduce marketing costs, reduce losses and evaluate, maintain or improve quality of livestock and poultry and animal, poultry and dairy products.

NRP 20610: Technologies and Facilities for Marketing Cross-Commodities

Research on instrumentation, refrigeration, packaging, transportation, marketing facilities and urban distribution. These functions represent a greater cost area for agricultural products than all of agricultural production.

NRP 20620: Insect Control in Marketing (Post-Harvest Insect Control)

Research to develop new or improved ways to prevent the post-harvest loss, damage, destruction or contamination by insects of food, feed, seed and fiber.

NRP 20650: Technologies and Products to Increase Exports of Agricultural Products

Meeting the needs of foreign markets for processed agricultural products that meet consumer acceptability and foreign governmental import restrictions.

NRP 20660: Systems for Overseas Marketing

To help expand foreign markets for agricultural products and thus contribute directly to improving our balance of payments. It focuses primarily on quality maintenance and handling methods for agricultural products, including horticultural crops, field crops, and livestock and animal products.

Examples of post-harvest technology research classified by the above system includes starch research. Starch is a major component of most cereal crops which are produced in great quantity in the U.S. Increased use of starch could significantly increase the farmer's return for his commodity by expanding the use of corn in products of greater value. The wet and dry milling industries producing starch are composed of many small operations with no research capability and a few large operations solely interested in food and feed uses of its products. The Northern Regional Research Center initiated a basic study of understanding the starch molecule and methods for chemically modifying it. This fundamental research has resulted in numerous starch derivatives that have multiple uses and impact directly on our socio-economic objectives.

- Super Slurper, which absorbs 1400 times its weight in water--a truly innovative, award-winning product has been adopted by several companies and has over 100 uses in consumer products.
- Starch Xanthate, which removes heavy metals from fluids has found significant use in pollution control.
- Pesticide encapsulation, currently under investigation, shows significant promise of improving pesticide effectiveness and reducing the levels required.

This research would be classified in CRIS as follows:

Goal IV. Expand the demand for farm and forest products by developing new and improved products and processes and enhancing product quality.

RPA 407. New and improved feed, textile and industrial products from field crops.

Activity 5400. Chemical and physical properties of food products.
5500. Developing new and improved food products processes.

Commodities:
1400 Corn
1700 Wheat

Field of Science:
1526 Chemistry - organic

Research Program Group 3.00 Crops (Field and Horticultural)

Research Program 3.01 Corn and 3.03 Wheat

Under MAPS the appropriate classifications would include NRP 20520 Processing Technologies - Field Crops, NRP 20590 Technologies for Marketing Field Crops. Several NRP's would also be applicable.

Instrumentation for Assessing Quality and Nutritive Value

A Beltsville, Maryland, scientist developed instruments using a near-infrared reflectance for rapid prediction of moisture, protein and oil content of grains and oilseeds. This remarkable instrumentation was adopted for grading wheat by regulatory agencies, such as the Federal Grain Inspection Service of the USDA and counterparts in Canada. It has potential uses for analyzing the composition and nutritive value of most food products. A similar technology has been developed to measure maturity and internal quality of fruits and vegetables. This instrumentation research was initiated in the 1950s seeking non-destructive methods for measuring food quality. Improved egg grading was an early accomplishment. Current research is on simplifying grain quality instruments so samples can be analyzed for nutrients without grinding. As the devices become cheaper they could be used to identify true quality of farm products at delivery, assembly points and destination, enabling farmers to receive fairer prices for their commodities. These developments help to ensure better quality food products for the consumer.

Explosion Puffing Fruits and Vegetables

To fill a void in post-harvest research the Eastern Regional Laboratory joined in a quest for a means of preparing high quality dehydrated food. This is overall the most energy efficient means of preservation and distribution of foods, but has generally lacked the necessary quality for consumer acceptance. The concept of explosion puffing and equipment was developed and provides products of freeze-dried quality by augmentation of the conventional air drying processes to which there is already industry commitment.

Explosion puffing should find wide application by industry in developing proprietary products from fruits and vegetables. Explosion puffed carrots are already an item of commerce, and there is evidence that blueberries and potatoes may soon be commercialized through product development by industry. The CRIS system would include this research under Goal IV, RPA 403 New and Improved Fruit and Vegetable Products and By-products. The MAPS system would be primarily under NRP 20510 and 20580, but the PHT classification best fits the need for management purposes.

- Research of Transportation of Perishable Commodities. Improved packaging and conditions of temperature, humidity and package atmosphere can reduce losses of fresh fruits and vegetables between harvest and consumption. To test new methods, experimental shipments are made from production areas to market areas, both domestic and foreign. All shipments must be received by scientists or technicians to evaluate product and to recover recording equipment that often accompanies the test shipments. Since origin and destination are seldom in the same region, a national coordination was initiated so that shipments could be made unaccompanied but intercepted by staff located near the destination. International shipments were coordinated in time so that one technician could meet shipments from several different locations in a single overseas trip. Without national leadership and guidance, cost of transportation research would have been much higher during the past seven years. Classification would be essentially the same as for the example above on explosion puffing.

XI. CONCLUSION

Research is defined as "investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories of laws" (Webster, 1977).

Information about what is already known about a subject, and the extent to which it is already being studied, is needed by scientists and by those who manage research programs. A systematic method of classifying research and an organized means of obtaining timely, up-to-date information on resources allocated to studies, progress made to date and plans for future emphasis is essential for optimum utilization of resources. Scientists, through literature search, computerized information retrieval systems (including systems such as SSIE, CRIS, MAPS, PARIS), personal correspondence with other scientists throughout the world, attendance at national and international scientific meetings and travel to other laboratories, obtain much of the information they need to identify gaps in knowledge and to determine which areas in their disciplines need further investigation. Science knows no geographic boundaries, and language barriers are overcome--not by an international classification system, but by individual scientists with common interests.

Research managers, though, need a system to enable them to allocate resources to high priority areas. Elected representatives, and staff employed to advise them, need information about how funds and other resources are being used, and what future priorities are envisioned to guide them in policy decisions that affect the use of taxpayers' dollars.

The strength of the U.S. agricultural research system has been attributed to its decentralized, pluralistic system of management. Consumers have been the primary beneficiaries, resulting from improved production, processing and marketing of food, fiber and renewable resources. The resources available to the scientists have varied, but they evidently have made judicious use of them, based on economic returns to the public from investments in research--i.e., approximately 50 percent return per annum.

During the past two decades emphasis has been placed on systematic allocation of publicly funded resources, based on thorough regional and national planning by users as well as producers of research results. Several classification systems have been developed to assist scientists, managers, policy makers and others in developing plans, allocating resources, reporting accomplishments, assessing results and in communicating. The CRIS system was developed by state and federal research leaders and the MAPS system was designed by SEA/AR specifically for research management purposes. Each has merits as well as limitations for agricultural research management purposes.

All State Agricultural Experiment Stations, Eligible 1890 Institutions, Forestry Schools, SEA/AR and most other federal agencies that conduct agricultural research report annual progress as well as resource allocation (SY's, funds) through the Current Research Information System (CRIS). It is relatively specific, yet flexible enough to accommodate new categories. The USDA SEA/AR system (MAPS) uses CRIS units as the basic reporting unit, and these are aggregated for reporting to higher levels of management. The manner in which individual projects are combined for reporting and planning differs between SEA/AR and the states and this is one area that needs to be refined.

Another area that needs improvement is the timeliness of reports. The time required by CRIS to obtain reports, enter them into the computer and report summaries of research is too great. Management decisions are being made without access to the most recent information. Within SEA/AR the Program Analysis Research Information System (PARIS) was developed to complement MAPS and provide more timely information. SEA/AR managers use the MAPS system to allocate support to the scientists as well as to monitor progress. This differs from the mechanism used by SEA/CR in that federal funds are allocated to states primarily by formula (Hatch, McIntire-Stennis, 1890). These formula funds are usually not earmarked, but there are instances in which the Congress has expressed preference for the funds to be used to strengthen specific areas, such as beef and forage, feed grains and soybeans. When this occurs, the CRIS system of classification is used to determine the base for each state, and directors allocate new funds to these high priority areas. Congressional priorities are also reflected in earmarked topics in the SEA/CR budget for special grants and competitive grants. The CRIS system is used for reporting results and resource allocations to those programs as well as those funded with state and federal formula funds.

Regional and national planning by state, federal and private agricultural research units requires a common classification system. The CRIS system serves this purpose for planning and coordinating programs. The information documented in the CRIS system includes research investigators and staff support, including scientist years, funds and performing organizations for individual projects. It tracks the objectives, approaches, current progress and publications of some 24,000 projects within the state/USDA research system A "cross-walk" is provided from the CRIS classification system to the program planning structure. The research program structure is composed of eight broad Research Program Groups (RPG's), subdivided into 49 Research Problem Areas (RPA's) which cut across RP's when the nature of the research is similar (Joint Council, 1980).

The SEA/AR National Planning Staff (NPS) are called upon by commodity groups (private industry), congressional staff and SEA/AR administrators to provide information on current research programs on specific commodities. The research information in the MAPS and CRIS are available to NPS scientists for such uses. Regional and national planning committees also could provide such information, based on data they obtain under the auspices of the Joint Council on Food and Agriculture Sciences. However, if the information is not timely and cannot be provided in the format requested, it will not be used effectively--if at all.

The USDA Science and Education Administration is responsible for administration of federally funded research, extension and higher education/resident instruction activities. A modified, improved classification system that could accommodate information needs for all units, including government and private institutions, would be desirable. The Joint Council on Food and Agricultural Sciences Program Structure Group recommended the development of a classification system to be used in "looking across all performers." When the Congress and other high level policy makers request information in a certain format, it must be provided, and it must be done rapidly. A rapid delivery, computerized information system, with accurate, complete, specific up-to-date information gathered regularly from scientists and research managers, and one that can be aggregated in a manner flexible enough to meet information needs of various levels of management, is needed. Private industry should be encouraged to participate as a full partner in the system. Both the CRIS and MAPS systems are deficient in timeliness and in not including private industry data, but each has merits. A system combining CRIS, MAPS and perhaps Extension Management Information System (EMIS) is recommended.

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Table 1. U.S. Authorizing Legislation for Federal Food and Agricultural Research and Closely Allied Agricultural Activities

	Organizational Entity	Date and Code of Authorization	Assigned Functions	Date Abolished or Current (1980) Status
1.	Patent Office	1836 (5 Stat. 117)	To make domestic and international collections of plants with commercial potential for U.S. Agriculture.	The patent office was transferred to the Department of Interior in 1849 and then to the Department of Commerce in 1925. The function, plant, and seed collections were transferred to the Department of Agriculture in 1862.
2.	Post Office	1839 Congressional appropriation	Distribution of free seeds to U.S. citizens for vegetable gardening.	
3.	U.S. Dept. of Agriculture	1862 by act of Congress (12 Stat. 387; 5 U.S.C. 511, 514, 516). Given Cabinet status in 1889. Homestead and Land-Grant College Acts also passed in 1862.	Provided for a Commissioner of Agriculture whose duty it was to acquire and preserve in his Department all information concerning agriculture which he could obtain by means of books, correspondence, and by practical and scientific experiments, by collection of statistics and by any other appropriate means within his power.	The USDA is among the larger of Cabinet level Departments and comprises more than 35 agencies.
4.	Bureau of Animal Industry (BAI)	1884 by act of Congress (23 Stat. 31; 7 U.S.C. 391).	To deal with prevention, control, and eradication of animal diseases and parasites, and research on development and production of livestock, meat, and poultry.	Under Secretary's Memorandum 1320, supp. 4, of Nov. 2, 1953 the BAI was abolished and the function transferred to the Agricultural Research Service, USDA. Current functional responsibility for research rests with SEA/AR, USDA by Secretary's order of Jan. 24, 1978 a authorized by PL 95-113, Title XIV, otherwise known as the Farm Bill of 1977.

Organizational Entity	Date and Code of Authorization	Assigned Functions	Date Abolished or Current (1980) Status
4. Cont'd.			Responsibility for control and eradication and quarantine of livestock and poultry diseases and insects currently rests with the Animal Plant Health Inspection Service.
5. Bureau of Plant Industry (BPI)	1902 by Agricultural appropriation act (31 Stat. 922).	To conduct research in the introduction, development, improvement, and culture of crop and horticulture plants. The original assigned function was expanded as follows: Agriculture appropriation act of 1936 transferred soil fertility and soil microbiology research from the Bureau of Chemistry and Soils to the BPI; by Secretary's Memorandum 784 of Oct. 6, 1938, the soil chemistry, physics, and soil survey activities of the Bureau of Chemistry and Soils were transferred to BPI. By Research Administration Memorandum 5, issued pursuant to EO 9069 of Feb., 1942, and in conformity with Secretary's Memorandums 960 and 986 the engineering research of the Bureau of Agricultural Chemistry and Engineering was transferred in Feb., 1943 to the Bureau of Plant Industry, Soils and Agricultural Engineering (BPISAE).	Under Secretary's Memorandum 1320, supp. 4, of Nov. 2, 1953 the BPISAE was abolished and all functions transferred to the Agricultural Research Service, USDA. Current functional responsibility rests with SEA/AR, USDA as authorized by the Farm Bill of 1977 (PL 95-131, Title XIV approved Sept. 29, 1977).

Organizational Entity	Date and Code of Authorization	Assigned Functions	Date Abolished or Current (1980) Status
6. Bureau of Chemistry	1902. By agricultural appropriation act (31 Stat. 922)	To investigate soil chemistry and fertility and the chemical make-up of plants.	The Bureau of Chemistry and the Bureau of Soils were combined in 1927 to become the Bureau of Chemistry and Soils. In 1935 the soil erosion investigations were transferred to the Soil Erosion Service (by order of Secretary on March 27, 1935) which on April 27, 1935 became the Soil Conservation Service by order of the Secretary of Agriculture pursuant to provisions of the Soil Erosion Act (49 Stat. 163; 16 U.S.C. 490-a-c). Other soils research activities of the Bureau of Chemistry and Soils were transferred to other agencies in 1938 and finally to the BPISAE in 1943 under Secretary's Memorandum 1320 supp. 4 of Nov. 2, 1943. Also in 1938 the remaining units of the Bureau of Chemistry and Soils and the Bureau of Agricultural Engineering were consolidated to become the Bureau of Agricultural Chemistry and Engineering. In 1943 the agricultural engineering research became a part of the BPISAE and the continuing agricultural chemistry research relating to crop utilization was named the Bureau of Agricultural and Industrial Chemistry.
7. Bureau of Soils	1902. By agricultural appropriation act (31 Stat. 922)	To conduct investigations into soil and water problems, soil bacteriology, and soil microbiology (legume nodulating bacteria). In 1906 the work was expanded to include soil survey and soil analyses.	

Organizational Entity	Date and Code of Authorization	Assigned Functions	Date Abolished or Current (1980) Status
8. Bureau of Entomology	1905 by agricultural appropriation act (33 Stat. 289).	To conduct research on the identification, host range and control of harmful plant insects. Later expanded to insects of man and animals, stored product insects, and also to include beneficial insects important to pollination of plants (bees), and for biological control (parasites and predators) of harmful insects. The Agricultural appropriation act of 1935 (48 Stat. 467) consolidated the disease control and eradication work of BPI into the Bureau of Entomology and Plant Quarantine in 1935.	Under Secretary's Memorandum 1320, supp. 4, of Nov. 4, 1953, the Bureau of Entomology and Plant Quarantine was abolished and all functions transferred to the Agricultural Research Service. In 1971 the responsibility for Federal action programs on control, eradication, and quarantine of insects and diseases of plants and animals was transferred to APHIS. Current functional responsibility for research on insects and diseases of farm animals and poultry and of agricultural and ornamental plants and stored products and insects of man rests with SEA/AR, USDA as authorized by the Farm Bill of 1977 (PL 95-113, Title XIV, 91 Stat. 981, 7 U.S.C. 3101).
9. Agriculture Extension Service	1914 by the Smith-Lever act (38 Stat. 372; 7 U.S.C. 341-348).	To help the public learn about and apply to everyday activities the latest technology and management knowledge developed through research by land-grant universities, Department of Agriculture, and other sources.	Function assigned to SEA/E in 1978 as part of the consolidation of several agencies into the Science and Education Administration under Secretary's order of Jan. 24, 1978 as authorized by the Farm Bill of 1977 (91 Stat. 981, 7 U.S.C. 3101).

Organizational Entity	Date and Code of Authorization	Assigned Functions	Date Abolished or Current (1980) Status
10. Bureau of Agricultural Economics (BAE)	1922 by agricultural appropriation act (42 Stat. 532; 7 U.S.C. 411).	By merger of two existing units of the Department of Agriculture the BAE was assigned responsibility as the chief economic and statistical agency of the USDA.	Abolished in 1953 with transfer of all marketing and transportation research to the Consumer and Marketing Service (USDA) and the production economics and farm management research to the Agricultural Research Service. In 1961 the economic research in the Department was concentrated in the Economic Research Service (ERS) created by Secretary's Memorandum 1446, Supplement 1.
11. Office of Human Nutrition and Home Economics (later designated a Bureau).	July, 1923 by Secretary's Memorandum 436, pursuant to the Agricultural appropriations act of 1924 (42 Stat. 1289). In 1943 redesignated the Bureau of Human Nutrition and Home Economics in accordance with Research Administration Memorandum 5 issued pursuant to EO 9069 and in conformity with Secretary's Memorandums 960 and 986.	To conduct research on food, fiber, and other products of agriculture contributing to everyday living, and on economic problems, including housing and household buying, that affect rural families.	Under Secretary's Memorandum 1320, supp. 4, of Nov. 2, 1953 the Bureau was abolished and the function transferred to the Agricultural Research Service. With establishment of the SEA under Secretary's order of Jan. 24, 1978 as authorized by the Farm Bill of 1977, the earlier function and other expanded human nutrition responsibilities were assigned to the Human Nutrition Center of SEA.
12. Bureau of Dairying (changed to Bureau of Dairy Industry by Agricultural appropriation act of 1927 (44 Stat. 499).	1924 by act of Congress (43 Stat. 243; 7 U.S.C. 401).	To conduct research on breeding, feeding, nutrition, and management of dairy cattle, and to conduct studies of dairy products and dairy by products.	Under Secretary's Memorandum 1320, supp. 4, of Nov. 2, 1953, the BDI was abolished and the functions assigned to the Agricultural Research Service. With establishment of SEA under Secretary's order of Jan. 24, 1978 the function was assigned to SEA/AR.

Organizational Entity	Date and Code of Authorization	Assigned Functions	Date Abolished or Current (1980) Status
13. Bureau of Chemistry and Soils	1927 by agricultural appropriation act of 1928 (44 Stat. 976) by combining the Bureau of Chemistry (established in 1902) and the Bureau of Soils (established in 1902).	Functions included research on (1) chemical and technological aspects of carbohydrates, proteins, crops, foods, industrial farm waste, insecticides, and fungicides, and plant dust explosions and farm fires, and; (2) soil microbiology, chemistry, and physics, fertilizers, soil survey, biochemical and organic nitrogen, and mechanical engineering.	Merged by order of Secretary on Oct. 16, 1938 with the Bureau of Agricultural Engineering to become the Bureau of Agricultural Chemistry and Engineering. In February of 1943 the Engineering Research became part of the BPISAE and the continuing agricultural chemistry research relating to crop utilization was named the Bureau of Agricultural and Industrial Chemistry (BAIC). The BAIC was abolished in 1953 under Secretary's Memorandum of 1320 of Nov. 2, 1953 and the function assigned to the Agricultural Research Service of the USDA.
14. National Arboretum	1927 by act of Congress.	Directed the establishment of a National Arboretum in Washington, D.C. for the purpose of research and education on trees, shrubs, and herbacious plants, under competent scientific direction and administered separately from the agricultural, horticultural and forestry stations of the Department.	Program is a continuing one which is guided by an advisory council appointed by the Secretary of Agriculture. Organizationally the National Arboretum's budget requests and fund allocations are through SEA/AR of the USDA.
15. Bureau of Agricultural Engineering (from 1921 - 1931 was known as Division of Agricultural Engineering of the Bureau of Public Roads).	1931 by agricultural appropriation act of 1932 (46 Stat. 1266). Merged with Bureau of Chemistry and Soils by order of Secretary on Oct. 16, 1938 to form the Bureau of Agricultural Chemistry and Engineering, and in 1943 the Agricultural Engineering research became a part of BPISAE.	To conduct research on farm structures, soil drainage, irrigation, and mechanical equipment. Also responsible for providing plans and services which involved agricultural engineering expertise.	Its entity as part of a Bureau was abolished in 1953 under Secretary's Memorandum 1360, supp. 4, of Nov. 2, 1953, to become a part of the Agricultural Research Service. Currentl the functional responsibility for agricultural engineering research rests with SEA//AR, USDA established under Secretary's order Jan. 24, 1978, as authorized by the Farm Bill of 1977.

	Organizational Entity	Date and Code of Authorization	Assigned Functions	Date Abolished or Current (1980) Status
16.	Bureau of Plant Quarantine	1933 by act of Congress (47 Stat. 640).	To control; eradicate, and quarantine exotic plant diseases which are a threat to U.S. agriculture.	Abolished in 1935 by merger with the Bureau of Entomology (as directec by the Agriculture appropriation act of 1935) to become the Bureau of Entomology and Plant Quarantine.
17.	Bureau of Entomology and Plant Quarantine	1935 by Agricultural appropriations act of 1935.	Functions include those originally assigned to the Bureau of Entomology (established in 1905) and the Bureau of Plant Quarantine (established in 1933)	Abolished in 1953 by Secretary's Memorandum 1320, supp. 4, of Nov. 2, 1953 and the functions transferred to the Agricultural Research Service. Currently, the eradication and quarantine function is a responsibility of SEA/AR, USDA.
18.	Soil Conservation Service	1935 pursuant to provisions of the Soil Erosion act (49 Stat. 163; 16 U.S.C. 590 a-r).	Mostly a Federal action program to provide technical assistance for helping farmers to preserve, control, and improve their soil and water resources by means of soil and water conservation practices. However, by order of the Secretary the soil erosion investigations of the Bureau of Chemistry, Soils, and Agricultural Engineering and the soil erosion nurseries of the Bureau of Plant Industry were transferred to the SCS in 1935. The soil erosion research was transferred to the Agricultural Research Service in 1953.	Still functioning as a separate agency outside of SEA, with the soil erosion research conducted on specified waterbeds being the responsibility of SEA/AR.

The Mission of Science and Education Administration, Agricultural Research (SEA/AR)

American agriculture is providing the Nation with food and fiber supplies unequaled in history. At the same time, the American agriculture system is helping other nations to meet the food and fiber needs of their expanding populations. The United States is exporting more farm products than any other nation, and through food production technology provides assistance to both the developing and the developed world.

The United States Department of Agriculture is legislatively mandated to help provide the Nation with adequate supplies of high-quality food and fiber, biomass for fuels, and sufficient natural resources for use in agriculture. A forward-looking, Federally funded and managed agricultural research organization is essential to the continuing fulfillment of this mandate.

The Nation's food and agricultural research system is built around (1) SEA/AR, which focuses on agricultural problems of broad regional, national, and international concerns; (2) the State agricultural experiment stations, which focus on local and regional problems; and (3) the food and fiber industry, which generally performs proprietary applied research and development. Together, this tripartite system carries out the basic and applied research necessary to provide a dependable supply of high-quality food and fiber to consumers, to develop renewable resources for energy, and to maintain a quality environment through sound husbandry of natural resources. The partnership between SEA/AR and the State experiment stations and their joint association with industry strengthens mutual capability to assemble and focus scarce technical skills and resources on high-priority problems.

Within this pluralistic and unique agricultural research system, SEA/AR plays a distinctive and well-identified role. Specifically, SEA/AR:

- Maintains and manages a nationwide, dynamic organization of scientists and research managers who (1) address new and changing problems and priorities without geographic or political constraints; (2) provide continuing technical and scientific information and guidance for key executive policy decisions, soundness of regulatory decisions, and legislative actions; and (3) look ahead to future research opportunities and potential scientific breakthroughs, which not only are challenging and exciting, but also are of a potentially high degree of importance in meeting the Nation's future problems.

- Maintains a corps of scientists recognized as national authorities in specific commodity, natural resource, and disciplinary fields. These scientists provide technical guidance and inspiration for ongoing research, serve as informal science advisors, and anticipate profitable and useful future research directions.

- Fulfills the diverse needs of agricultural users--from farmers to consumers--by focusing resources, facilities, and effort on specified problems and opportunities of national interest, national security, and broad regional concern related to natural resources and the food, fiber, energy chain. Areas of emphasis include natural resource conservation; crop and animal production, protection, processing, and distribution; and consumer-related problems such as food safety and quality.

- Responds to the food and agriculture-related research needs of Federal action and regulatory agencies and, when appropriate, conducts independent tests and evaluations in the best interests of the U.S. Government.

- Participates as the Federal in-house research component of SEA with other sectors of the agricultural research system in planning, coordinating, and executing high-priority national and regional research programs.

- Attacks problems important to the Nation that no one State or private group has the resources, facilities, need, or incentive to solve. In these cases, SEA/AR provides specific capabilities needed to complement and support research programs involving cooperators and partners.

- Works with the Science and Education Administration, Cooperative Research (SEA/CR) in encouraging and facilitating cooperation and coordination of agricultural research conducted by the States, the 1890 Land-Grant Colleges and Tuskegee Institute, and the U.S. Department of Agriculture.

- Interacts with and responds to needs of Extension by conducting research to solve special problems based on feedback supplied by Extension personnel.

- Provides support and training opportunities for agricultural higher education programs.

- Conducts research and development to meet international needs as determined by policy of the U.S. Government and the now recognized global nature of agriculture.

- Carries out research and development programs as required to fulfill the mandates of Congress, the President, and the Secretary of Agriculture.

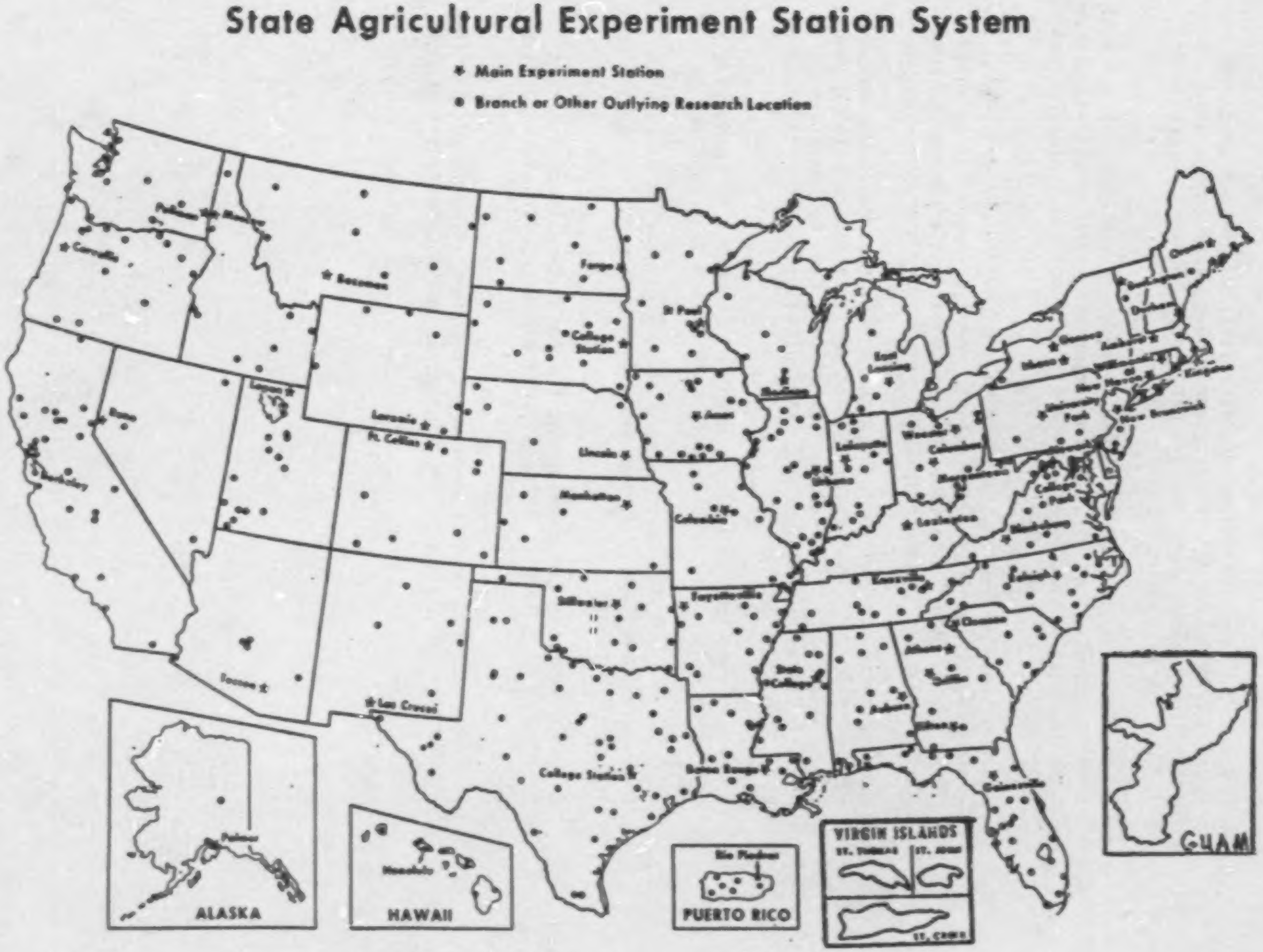
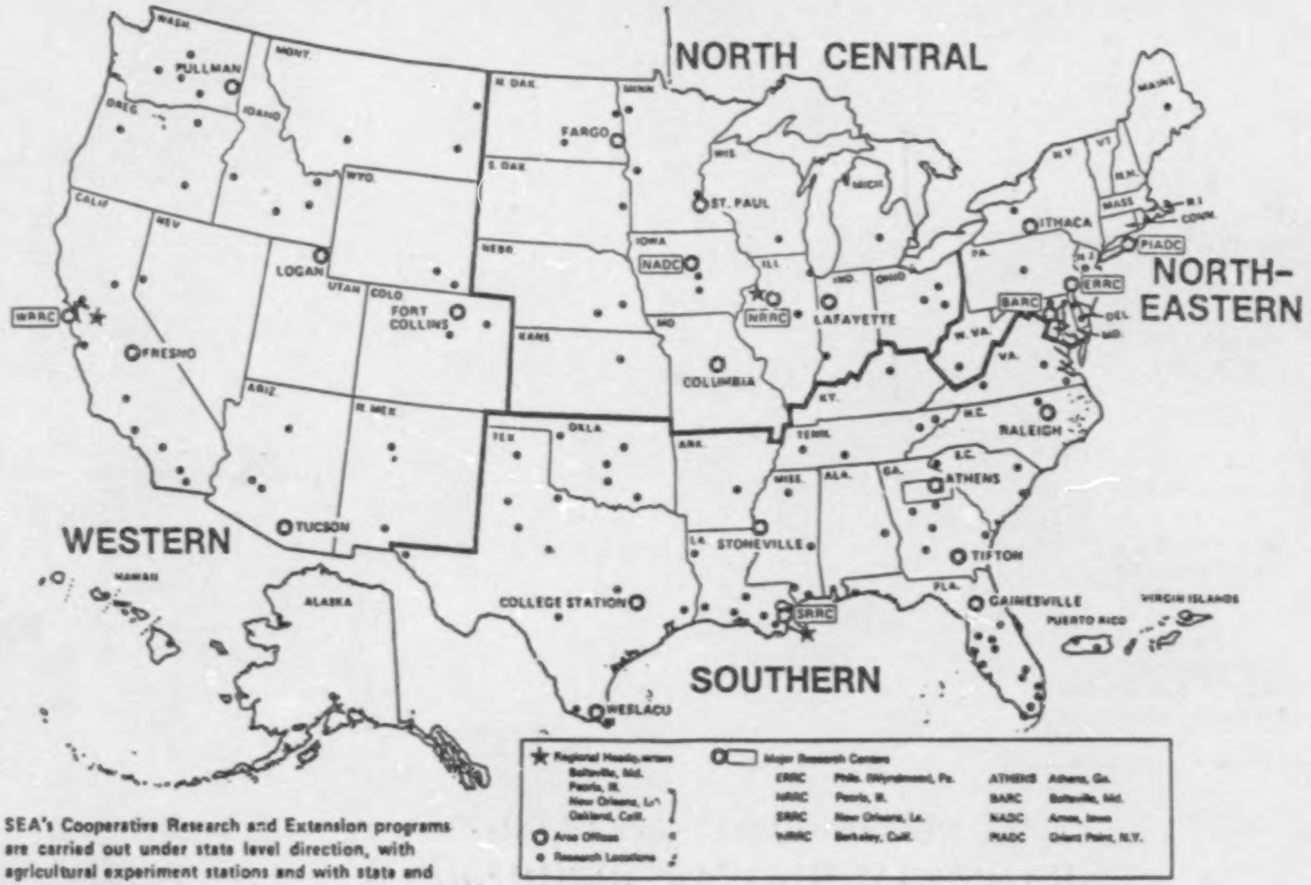

State Agricultural Experiment Station System
Main Experiment Station
Branch or Other Outlying Research Location
Pullman
Moscow
Corvallis
Bozeman
Reno
Davis
Berkeley
Logan
Laramie
Ft. Collins
Tucson
Las Cruces
Fargo
College Station
St. Paul
Lincoln
Manhattan
Stillwater
College Station
Ames
Columbia
Fayetteville
Madison
East Lansing
Urbana
Lafayette
Wooster
Columbus
Lexington
Knoxville
State College
Auburn
Athens
Baton Rouge
Gainesville
Clemson
Raleigh
Blacksburg
College Park
University Park
New Brunswick
Geneva
Ithaca
Amherst
Kingston
New Haven
Orono
ALASKA
Palmer
HAWAII
Honolulu
PUERTO RICO
Rio Piedras
VIRGIN ISLANDS
ST. THOMAS
ST. JOHN
ST. CROIX
GUAM

Figure 1. State Agricultural Experiment Station System

SCIENCE AND EDUCATION ADMINISTRATION
Regional Organization—Agricultural Research

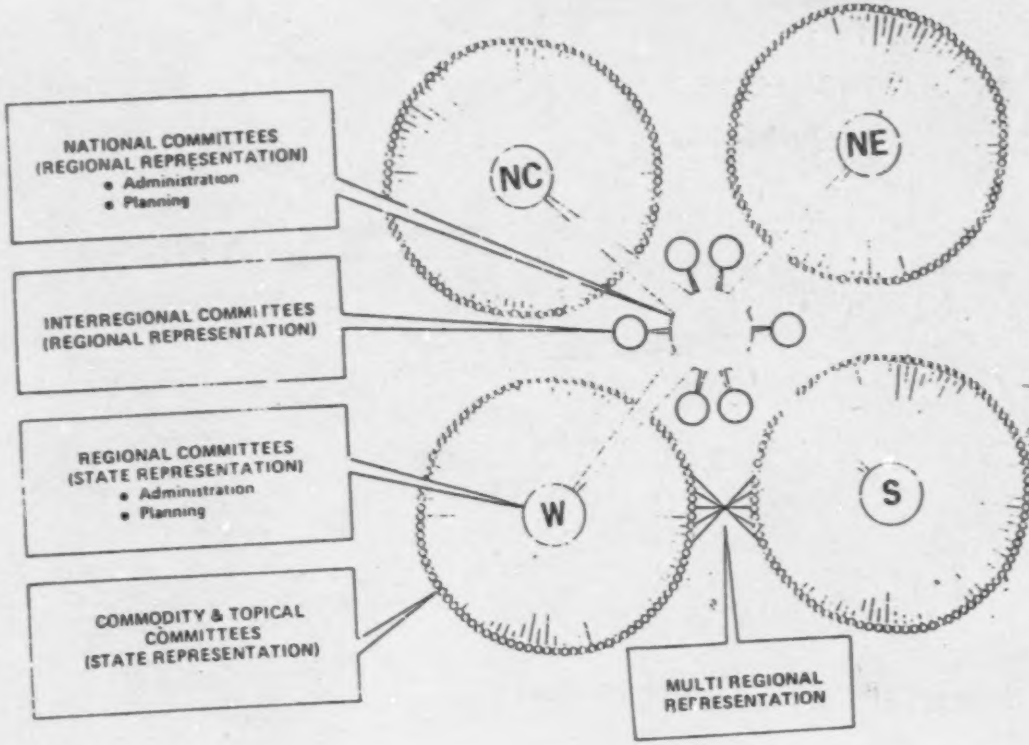

NORTH CENTRAL
NORTH-EASTERN
WESTERN
SOUTHERN
WASH.
PULLMAN
OREG.
IDAHO
MONT.
CALIF.
NEV.
WRRC
FRESNO
LOGAN
UTAH
WYO.
COLO.
FORT COLLINS
ARIZ.
N. MEX.
TUCSON
N. DAK.
FARGO
S. DAK.
NEBR.
KANS.
OKLA.
TEX.
COLLEGE STATION
WESLACO
MINN.
ST. PAUL
IOWA
NADC
MO.
COLUMBIA
WIS.
ILL.
NRRC
IND.
LAFAYETTE
MICH.
OHIO
KY.
TENN.
ARK.
LA.
STONEVILLE
MISS.
ALA.
SRRC
GA.
ATHENS
TIFTON
FLA.
GAINESVILLE
S.C.
N.C.
RALEIGH
VA.
W. VA.
PA.
BARC
ERRC
DEL.
MD.
N.J.
N.Y.
ITHACA
VT.
N.H.
MAINE
MASS.
R.I.
CONN.
PIADC
HAWAII
ALASKA
PUERTO RICO
VIRGIN ISLANDS
★ Regional Headquarters
Beltsville, Md.
Peoria, Ill.
New Orleans, La.
Oakland, Calif.
Area Offices
Research Locations
Major Research Centers
ERRC Phila. (Wyndmoor), Pa.
NRRC Peoria, Ill.
SRRC New Orleans, La.
WRRC Berkeley, Calif.
ATHENS Athens, Ga.
BARC Beltsville, Md.
NADC Ames, Iowa
PIADC Orient Point, N.Y.

SEA's Cooperative Research and Extension programs are carried out under state level direction, with agricultural experiment stations and with state and county offices respectively.

Figure 2

Experiment Station Research

PLANNING AND COORDINATION



NATIONAL COMMITTEES
(REGIONAL REPRESENTATION)
- Administration
- Planning

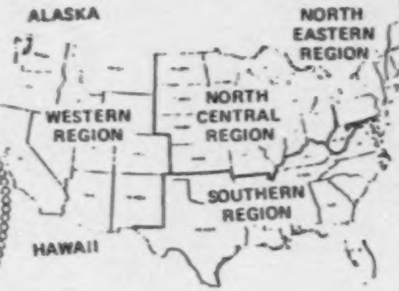
INTERREGIONAL COMMITTEES
(REGIONAL REPRESENTATION)

REGIONAL COMMITTEES
(STATE REPRESENTATION)
- Administration
- Planning

COMMODITY & TOPICAL
COMMITTEES
(STATE REPRESENTATION)

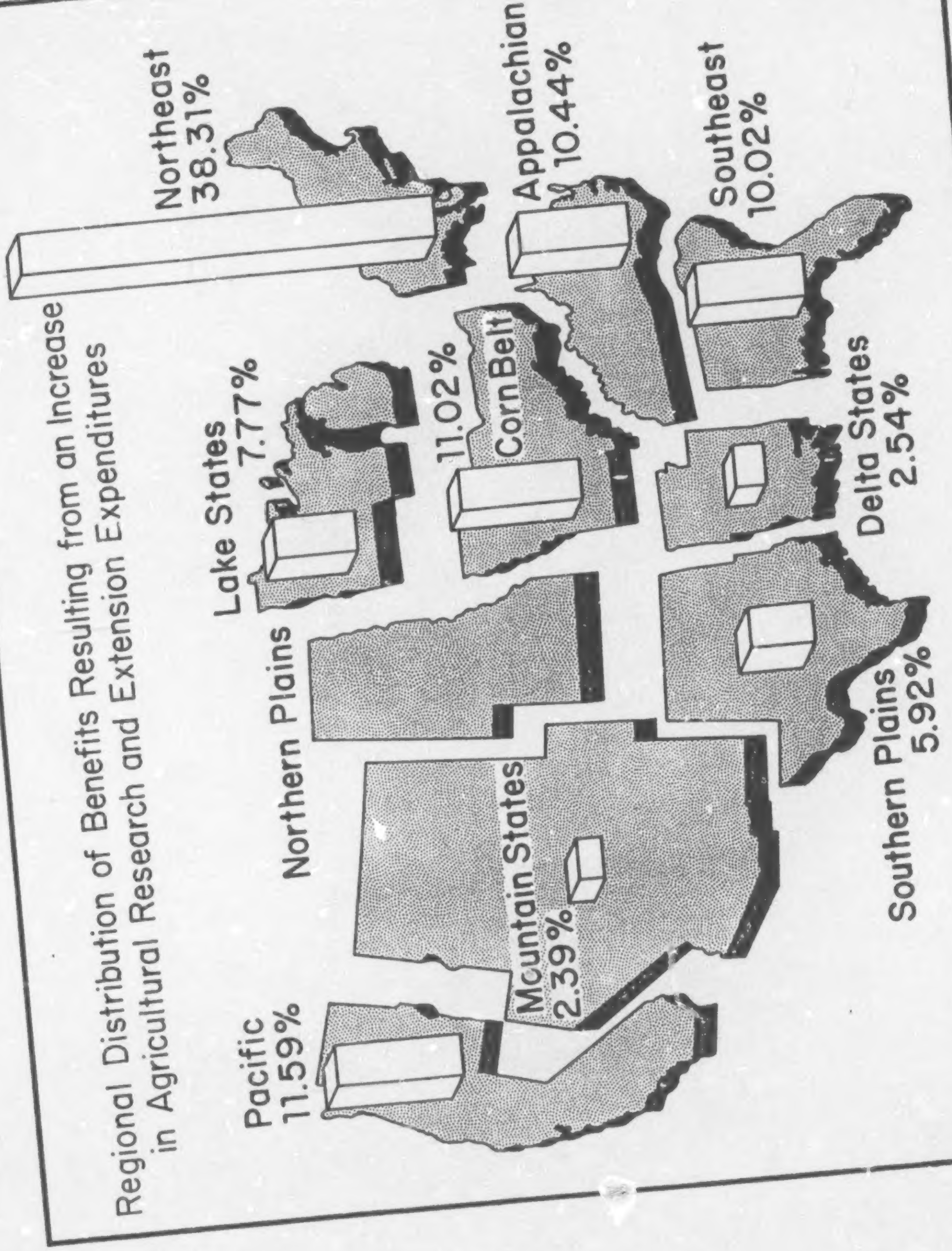
MULTI REGIONAL
REPRESENTATION

AN ORGANIZED PLANNING
& COORDINATING STRUCTURE
REPRESENTATION
- National
- Regional
- State
- Commodity
- Scientific Topic


ALASKA
NORTH EASTERN REGION
WESTERN REGION
NORTH CENTRAL REGION
SOUTHERN REGION
HAWAII

A-12

Figure 3


Regional Distribution of Benefits Resulting from an Increase in Agricultural Research and Extension Expenditures

Ziemer, et al., 1981

Figure 4

Commissioned Paper II

EFFECT OF ORGANIZATION, POLICY AND PROCEDURES ON RESEARCH MANAGEMENT

Roy L. Lovvorn*

Office of Technology Assessment

November, 1980

*Input Provided by Mark Buchanan and Wayne Rasmussen

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Preface

Much of the information for this paper was obtained from interviews with research scientists and administrators, both within the USDA and at several land-grant universities during May and June, 1980. Since that time the author has learned of steps being taken within SEA to improve communications between the USDA and their state partners. Hopefully this trend will continue because the objective of the paper is to improve--not degrade.

SEA is now considering transferring the National Program Staff of SEA/AR to the field. The agency claims to be having difficulty recruiting competent people to work in Washington and believes that university people could be employed if they could continue to live and operate from their home base. The Director of SEA has also indicated that future duties of the NPS are to be more advisory to the research staff and less as staff assistants to the administrator of AR.

Such a further decentralization of AR would weaken the role of the administrator and add to the concentration of power in the Director's office. The theme of this paper has been to move in the opposite direction. The NPS role in planning and budgetmaking must be done in concert with others and not as isolated individuals. Their proper function is serving as national subject matter advisors and distributing them throughout the United States would reduce their effectiveness and greatly add to their travel budgets.

The Author
October, 1980

Glossary

AMS	Agricultural Marketing Service
ARS	Agricultural Research Service
AR	Agricultural Research
CSRS	Cooperative State Research Service
CR	Cooperative Research
EPR	Environmental Protection Agency
ES	Extension Service
EXCOP	Experiment Station Committee on Organization and Policy
ESCS	Economics, Statistics, and Cooperative Service
FS	Forest Service
IPS	Intergovernmental Personnel Act
JPE	Joint Planning and Evaluation
NPS	National Program Staff
OICD	Office of International Cooperation and Development
OTA	Office of Technology Assessment
PPS	Program Planning Staff
SAES	State Agricultural Experiment Stations
SEA	Science and Education Administration
SCS	Soil Conservation Service
USDA	United States Department of Agriculture

Summary

Agricultural research in the United States is unique in that for 100 years both the USDA and the states have played major roles in contrast to many countries of the world where centrally funded programs have predominated. Some critics have considered the United States' system wastefull and duplicatory, but to the objective thinker the evidence is clear that agricultural research has been a good investment.

Societal changes have necessitated changes in research both in content and organizational structure. Problems are more complicated but more sophisticated tools are available. Society is much more concerned with environmental problems and is thus reflected in the agricultural research underway.

The human element is always present in research. The art of working together is of continuing concern to the investigators themselves and to their supervisors. Likewise, the partnership between the federal and state research programs is one that requires continuous dialogue. Nevertheless the success of the U.S. system is one generally recognized throughout the world and supported by state and national decisionmakers.

SAES had their beginning as humble institutions, often with a single laboratory room and a single scientist. They justified their existence in terms of service to farmers at first and later to the general public. Now they are a major unit of the Land-Grant University. Their buildings, equipment, well-trained staff and graduate students makes them the envy of other units of the university.

Their concern now is one of satisfying a hungry customer (their farmer constituents), the consumer and environmentally oriented public and maintaining a healthy working relationship with other branches of the university. They must also operate strong disciplinary programs to train graduate students and at the same time maintain multidisciplinary programs for problem-solving purposes.

Their present organizational structure has served them well and should be continued. Relationships between scientists (both state and federal) is reasonably satisfactory. Relationships between scientists and administrators varies from individual to individual, but, in general, is good.

The so-called director of a state experiment station is somewhat of a misnomer. He is more of a coordinator and leader. True research is not "directed." The ideal director has a strong research background, a compassion for his associates, a dedication to service to mankind and a talent for dealing with scientists, administrators, politicians and the general public. At the same time, he must possess managerial skills that enable him to say "no" and make it stick. He is in reality a leader, not a director. Structurally the station should include forestry, veterinary medicine and home economics in addition to traditional agriculture. His position is one of working cooperatively with the directors of extension and academic affairs under the leadership of the dean. His responsibility as defined in the Hatch Act should be preserved.

Regionally and nationally he must represent his state, but not at the expense of cooperating in regional projects and of joining hands with the USDA in the solution of problems that are broader than the state boundaries. The present organization provides for such operations.

Research in the USDA began with the collection of agricultural statistics in 1856. Later work was initiated in animal health, chemistry, soils, plants, entomology, dairying, home economics and agricultural engineering. Originally these units functioned essentially as autonomous bureaus but in 1953, they were consolidated into the Agricultural Research Service. At that time the Bureau of Agricultural Economics was abolished. These functions later became the Economic Research Service and more recently the Economics, Statistics, and Cooperatives Service.

Initially the ARS was organized along the lines of both commodities and disciplines with investigation leaders having national responsibilities. They provided program leadership and controlled the budget. Such an arrangement provided strong commodity leadership that was appreciated by commodity groups and SAES scientists as well as the ARS scientists themselves. The structure did not provide for maximum cooperation between disciplines. SAES directors often found it awkward to deal with a number of investigation leaders.

A major reorganization in 1972 regionalized the ARS into four regions that were further divided into geographic areas. This structure decentralized the decision-making process but was a serious temporary blow to morale. These areas are not along ecological lines but form an artificial grouping of adjacent states. The area director is therefore an administrator over a range of disciplines and commodities with little opportunity for professional leadership.

CR is the thread in the partnership between the USDA and the states. It has served a useful role in coordinating work between states, in improving the quality of work within the states and in maintaining a relationship between the USDA and the states. It could, however, serve a much more forceful role in assisting the states if SAES directors were willing to utilize its full potential.

SEA was created by the USDA in an attempt to improve coordination of research, extension and teaching at all levels of goernment, federal, state and county, as mandated in Title XIV of the Food and Agricultural Act of 1977. AR, CR, ES, the National Agricultural Library, Human Nutrition and higher education were combined into one agency with certain functions left to the Administrators and other transferred to the Director of the new agency. The concept seems to be a good one.

Three types of problems have been encountered. One is merely growing pains. The old house was dismantled before plans for the new one were formalized. Time will probably correct this problem. The second is one of personnel ceilings. With little or no authorization for additional personnel a superstructure has been built at the expense of existing agencies. The solution to this problem is not so obvious, although some of the superstructure seems hard to justify. Many of the operational decisions now being made in the Director's office could be transferred to the individual administrators without weakening the concept of Title XIV. The third problem has to do with attitude. For more than 100 years the states have collaborated with the federal government in agricultural research. Recognizing that the collaboration has not been easy, yet progress has been made and effective working relationships maintained. The Hatch Act of 1887 specifically provides for a partnership and for the matching of state and federal dollars. Currently less than 20% of the SAES budgets come from Hatch funds and yet the notion of national planning and integrated budget preparation as envisioned by some within SEA is that national research needs and priorities can best be determined by listening to many people and then assuming that the intellect is within the USDA. Some listening by SEA and cool-headed dialogue between SEA leaders and SAES directors are suggested for preserving a great research partnership.

Critics have questioned the present organization's ability to identify national and regional gaps in research. The Joint Council on Food and Agricultural Sciences and the National Agricultural Research and Extension Users Advisory Board both are designed to identify such needs. The Joint Planning and Evaluation staff (JPE) of SEA provide staff support for these two advisory groups. With JPE there is the Program Planning Staff (PPS) that takes the various inputs and develops an integrated budget. Inputs also come from AR and CR, the latter including needs of the SAES directors as requested through ESCOP. The mechanism is there for identifying high priority needs and gaps in the system. The problem is to make the system work.

There are pros and cons of any organizational structure. There were gains and losses in the reorganization of ARS in 1972, with probably more losses than gains. There have also been losses within AR and CR in the creation of SEA in 1977. The concept of SEA appears sound and hopefully suggestions that follow will improve its functions and help improve morale.

EFFECT OF ORGANIZATION, POLICY AND PROCEDURES ON RESEARCH MANAGEMENT

I. INTRODUCTION

Agricultural research in this country had its beginning at Mount Vernon when Washington tested soil treatments on wheat. President Jefferson was also interested in improving agriculture through research. Legislative landmarks were the creation of the Department of Agriculture and legislation authorizing the land-grant colleges, both enacted in 1862. The Hatch Act of 1887 resulted in each state establishing an experiment station. Since that time the United States has had a national and a state agricultural research system. Critics have said the two systems are wasteful and duplicatory. Proponents have said it is the greatest system in the world. For nearly one hundred years, the federal-state partnership has been continuously dialogued, often with minor disagreements but both profiting from the association.

Many changes in organization, both state and federal, have occurred in these one hundred years. Complexities of current problems coupled with competition for funds for other societal needs dictate that research management be scrutinized and hopefully improved. This paper is a part of a larger study on United States Food and Agricultural Research Assessment of the Office of Technology Assessment (OTA).

II. HISTORICAL DEVELOPMENTS AFFECTING RESEARCH MANAGEMENT

A. Environmental Problems

The appearance of Rachel Carson's book, Silent Spring, in 1962, emphasized the role of side-effects in the use of agricultural chemicals and had an impact on the thinking of agricultural scientists. Although the book contained some statements not substantiated by facts, it did have a tremendous impact in the eyes of the public.

Since that development, researchers have been more aware of the impacts of their research upon society and have accepted, though somewhat reluctantly, the responsiblity of thoroughly evaluating all aspects of their activities. Simultaneously society in general has become much more concerned with the environment. An example is the creation of the Environmental Protection Agency (EPA). Although the rules and regulations developed by EPA have frustrated agricultural research in minor ways, they realize and appreciate the necessity of a healthy environment. One administrative action of EPA that does irritate research workers, both state and federal, is the practice of contracting with consulting firms to make specific studies and in turn the consultants coming to the research people for the information.

B. Consumerism

Modern society is presently very consumer-oriented. The backgrounds of the assistant secretaries within the Department of Agriculture is an indication of the Department's response to the subject. Likewise many members on the National Agricultural Research and Extension Users Advisory Board represent consumer groups. SAES have been reluctant to appoint consumer-oriented individuals on their advisory committees, their rationale being that all are consumers. The trend is changing, however, and SAES directors are responding to the change in attitude.

C. Accountability

Leaders, be they preachers, politicians or educators have all developed an "affair with accountability." It is like motherhood and patriotism -- everybody is shouting from the house top.

Basically accountability is integrity. An honest person is one concerned with spending his time wisely as well as spending his budget resources wisely. Accountability is a matter of personnel at all levels understanding what is expected of them and their superiors providing positive leadership in fulfilling that commitment. Loading researchers with forms detailing every minute of their time is not a way to achieve accountability.

Agricultural research institutions are accountable in two ways. SAES are fiscally accountable through their own university business offices and state auditors. Likewise USDA research agencies are fiscally accountable to their business offices and to the General Accounting Office. Of far greater significance, however, is program accountability. Researchers and administrators, both state and federal, have their constituencies and they feel a genuine responsiblity to them. Within a state, a particular commodity association keeps its eye on what is going on research-wise so that producer and user remain on the same wave length. The same is true for the USDA, for example, the National Cotton Council's vigilance over cotton research.

D. Changes of Status of Experiment Stations Within the Land-Grant Universities

Changes in the status of experiment stations are best illustrated by changes within the National Association of State Universities and Land-Grant Colleges. The national association was formally organized in 1887 as the Association of American Agricultural Colleges and Experiment Stations. Earlier consideration had been given to a separate association for the experiment stations, but the college presidents insisted that they be a part of the organization. As the "agricultural and mechanic colleges" evolved into truly universities, the units and functions of the Association likewise evolved. Today the Association represents all aspects of the Land-Grant University and the experiment station section, though still important, is only one of many sub-units.

Experiment stations began as humble endeavors, poorly equipped and modestly staffed, to work on current but pressing problems. Their status increased as they produced useful information. By the middle of the twentieth century, the station was the envy of other branches of the university because of their ability to secure support, to attract scientific personnel and to foster graduate education. One university of which the writer is familiar has six major buildings named in honor of former directors -- but none since 1940.

In the early days the director reported directly to the Chancellor or President. Likewise he defended his budget before the state legislature. The experiment station was a substantial part of the college or university and the director was a "big man on campus". In many cases the station staff was engaged in full-time research with little inter-action with the teaching faculty and only a courtesy interaction with extension personnel. The staff from the three factions reported to different bosses.

As the Association developed, it created sections for extension and instruction, in addition to research, with formal organizations and officers elected from within its ranks. About the midpoint of the twentieth century more and more of the land-grant universities began naming over-all deans of colleges of agriculture with broad responsibilities over the three traditional functions. Thus the station director reported to the dean rather than the president. These new administrative officers visited the three sections of the Association, but really had no home. Now, however, they are recognized as an integral part of the Association as well as being important administrators. locally. Back on the campus the same sort of integration was taking place. Schools or colleges of agriculture were naming administrative officers with over-all responsibilities including research, extension and teaching. Thus experiment station directors were one notch lower in the administrative structure. These changes were being made in the name of coordination and cooperation.

Earlier most university departments had integrated their teaching and research functions and program direction in extension was later placed under the general direction of the department head.

Beginning in the 1950's, there began large sources of funding from the National Science Foundation, the National Institutes of Health, and the National Aeronautics and Space Administration. These grants were not necessarily oriented toward the state program but rather toward the particular interest of the individual scientist and to the source of funding. In spite of what station directors claimed, they were becoming less influential in terms of developing and leading their own programs.

Thus the status of the station has risen, plateaued and to a degree subsided, during the first one hundred years of their existence. Their contributions to society have assured them an important role in the future regardless of the organizational chart of the university.

E. Changes of Status of Research Agencies within USDA

Congressional support for agricultural research begain in 1856 when the appropriation bill provided for "collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement and distribution of cuttings and seeds." (6) As research expanded it was organized into bureaus as follows:

Bureau of Animal Industry -- 1884
Office of Experiment Stations -- 1887
Bureau of Chemistry -- 1902
Bureau of Soils -- 1902
Bureau of Plant Industry -- 1902
Bureau of Entomology -- 1905
Bureau of Dairy Industry -- 1924
Bureau of Home Economics -- 1924
Bureau of Agricultural Engineering -- 1931

In 1944 the Bureaus of Soils, Plant Industry, and Agricultural Engineering were combined into one. Each of the above bureaus was headed by a chief, reported to the Secretary, and operated very independently of each other.

The ARS was established in 1953, consolidating most of the physical, biological, chemical and engineering research of the USDA within a single organization, headed by an Administrator. The research was organized into six main areas of work, namely: (1) farm research; (2) marketing research; (3) nutrition, consumer, and industrial-use research; (4) research in foreign countries; (5) regulation and control programs; and (6) management programs. Some bureau chiefs found it very difficult to adjust to the new organization, but as they were relieved or retired, the new organization performed more smoothly.

With the establishment of the Agricultural Research Administration and later the ARS, the Office of Experiment Stations became a division of it. In 1961, under a new Secretary, the Cooperative State Experiment State Service (later to become the CSRS) was established, again giving the agency equal status with other research agencies within the USDA. (5) There had been discussions between the Secretary and the Land-Grant community throughout the period that the state-federal relations office had lost its identity.

The ARS was reorganized again in 1972 at which time it was essentially decentralized into four regional offices. The rationale offered was greater autonomy in the field, a better mechanism for multidisciplinary research at the scientist level and better liaison between ARS area and regional administrators and SAES directors. The latter have reacted very favorably to the reorganization. Evidence does suggest the organization is a better approach to problem solving. Critics have pointed out the loss in national planning and coordination when there ceased to be a national commodity leader at Beltsville. Both state and federal scientists have suffered because of this change. National commodity groups have been particularly critical of the change because they feel a lack of national direction within the AR research program. Many state research sicentists are also unhappy with developments because of the absence of what they think of as a national research leader in their particular commodity. Likewise the new system places a greater emphasis on a problem-solving approach and less on the development of scientists as individuals. The incentive for original work is often lost in joint or team endeavors. Many scientists are not geared mentally to working as a team. Furthermore, many of them resent the necessity of spending time in a team effort when the pay off in terms of professional recognition is minimal. A recently retired AR employee perhaps summarized very well when he said the system is not as critical as the person. Morale always suffers when you reorganize.

Economic research has often come under attack both from Congress and from special interest groups, yet it is constantly called upon to assist in developing agricultural policy. In 1953 the Bureau of Agricultural Economics was abolished as a result of years of attack. The research responsibilities were assigned to the Agricultural Marketing Service and the Agricultural Research Service. The work was brought together again in 1961 with the establishment of the Economic Research Service. The new agency was assigned responsibility for all economic research in the Department including that in the foreign area. From time to time the agency was reorganized. The major result, so far as research was concerned, was greater emphasis on policy analysis and aggregative research. By the mid-1960's, work in the economics of the individual farm and agricultural marketing had almost disappeared.

On October 5, 1977, the Economic Research Service, the Statistical Reporting Service and the Farmer Cooperative Service were combined into the Economics, Statistics, and Cooperatives Service. Late in 1980 the Farmer Cooperatives Service will again become a separate agency, leaving the Economics and Statistics Service as the major economic research agency. At that time, the Commodity Economics, the Foreign Demand and Competition and the National Economic Analysis divisions were combined into the National Economics Division and the International Economics Division. One reason for the reorganization was to bring about a closer relationship in the national and world aspects in the monitoring and forecastng functions and in the analysis and research activities. The emphasis upon policy analysis and on aggregation continued.

III. STATE AGRICULTURAL EXPERIMENT STATIONS TODAY

State agricultural experiment stations (SAES) had their real beginning with the passage of the Hatch Act in 1887 . . . "that in order to aid in acquiring and diffusing among the people of the United States useful and practical information on the subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under the college or colleges or agricultural departments of clleges . . ." (5) Schools or colleges of agriculture had their beginning with the passage of the so-called Land-Grant College Act of 1862, the same year the United States Department of Agriculture came into existence. Historically and in reality the experiment stations have been the research arm of the colleges of agriculture.

The basic structure in most land-grant universities consist of an overall administrative officer. The title may be vice president for agriculture or dean of agriculture. The three functional units of research, extension and teaching are usually headed by a director, reporting to the dean who in turn is administratively responsible to the chancellor or president. Ideally the dean (or vice president for agriculture) performs an important coordinating and public relations role but leaves the research program development to the SAES director and his staff. Unfortunately some deans engage in many of the details that could best be handled by their subordinates. There are variations in the organizations in some land-grant universities. Units of forestry, fisheries and wildlife exist as separate schools in some institutions; in others they are a part of home economics. In most instances, however, the director of the agricultural experiment station is responsible for research in forestry and home economics. Likewise the biological sciences may be within the college of agriculture or it may be administered through another college. Such departments as plant pathology and entomology are normally within the college of agriculture. Departments of genetics, microbiology, botany, zoology and biochemistry may or may not be administered within the college of agriculture.

In the early days, the above structure was not typical. The first experiment station was established in 1875, but the real impetus for the stations' beginning was the Hatch Act of 1887. Extension got its significant push from the Smith-Lever Act of 1914. College teaching, on the other hand, began soon after the 1862 legislation. For many years, therefore, the teaching, research and extension tended to be administered separately and to be staffed by different individuals. With the passage of time, the teaching and research have become, with some exceptions, completely integrated. With few exceptions, faculty members of a given department will do both research and teaching. The integration of extension has been slower and in many universities the extension personnel are still separate. They may or may not be under the administration of the department head. The trend, however, has been toward the latter.

Teaching and research are theoretically compatible functions. Teaching requires one to keep abreast of the literature and to keep in touch with practical problems through interaction with students. Research keeps one intellectually stimulated and the tendency to become stale and out of date is greatly diminished. There are some practical problems, however. Some people are incapable of performing two functions simultaneously. They either neglect their research at the expense of teaching or they do a poor job of teaching because of their consuming interest in research. Also, some are just poor teachers because of personality, attitude or lack of interest. Most administrators have solved the problem by assigning individuals to functions they do best, be it full-time teaching, full-time research, or as in most instances joint teaching and research.

Integration of functions has also caused some budgetary problems. Historically, research and extension have been better supported than academic affairs. They have separate line item budgets, whereas teaching support is a part of the university budget and not clearly identified with the college of agriculture. This is particularly true in such items as travel to professional meetings. The department heads feel compelled to exploit SAES funds to accommodate his total travel needs. There are also other ways that teaching benefits at the expense of the station budget. Nevertheless the advantages of an integrated research-teaching relationship far outweigh the disadvantages.

Currently in some institutions the extension personnel is not only integrated into the departmental structure, but they also have joint appointments in extension-research-teaching. A more recent trend has been the engaging of extension people in applied research as a recognized part of their job descriptions. The rationale for such developments are twofold: (1) present day extension personnel have the same level of training as researchers, i.e., a Ph.D. degree and an interest in research, and (2) the existence of a real need for applied research that is not being done by the research staff.

The close working relationship between the researcher and the extension specialist is one of the great advantages of the land-grant university concept. They are housed together, or adjacent to one another, confer with each other regularly, thus keeping close contact with each other. Both parties benefit from the relationship. This arrangement is unique to the United States land-grant system.

The definition of specific extension program objectives and target clientele is left mainly to the states and counties. The greatest influence on the choice of extension programs is generally found at the county level because of their grass roots heritage. The system responds effectively to national problems that are also felt at the state and local level. The response is weakest when the need is confined to disadvantaged groups unable to communicate their needs and when the incentive of individuals seeking information is lacking, as in the case of pressure for improved environmental quality. Extension now has a problem of identifying and serving its clientele. Their greatest impact in the past has been with commercial farmers. More recently they have directed more attention toward small farmers and other disadvantaged groups. They are attempting to serve both groups, but some critics have implied they are attempting to serve too broad a spectrum with less than satisfactory results (2).

Agricultural research is funded by state appropriations, gifts, receipts from sales of products and federal funds. The latter are largely Hatch funds or grants from the Department of Agriculture and grants from other federal agencies. Although the latter are programmed through the director's office, the final sign-off is in the university business office and/or the vice president for research.

The Hatch Act amended clearly states the duties and responsibilities of the SAES director. He has responsibilities in developing a local program and in dealing effectively with the USDA and the Congress. The broad areas of research are identified by the SAES director and his staff in consultation with department heads, scientists, the dean/vice president for agriculture and statewide commodity groups, research users, and other advisory groups. In some cases, during the "soft money" era of the fifties and sixties, researchers were very successful in obtaining support for their work that was oriented more toward the grantor and less toward the meeting of local goals. Directors have gained experience in coping with their staff in such matters and that, coupled with less grant funds available, has minimized this problem in recent years. Once an area of research is agreed to, the researcher is expected to develop his own project outline, method of procedure, etc. The department head provides counsel and guidance, but not day-to-day instructions. The line between "over" and "under" administration is a very fine one.

The Hatch Act amended provides for up to twenty-five per cent of the funds going into regional research. The details will be discussed in another section of this paper. The concept is an excellent one, but procedurally it leaves something to be desired.

A. Constraints

Except for personality differences the colleges of agriculture are well organized with lines of communications understood and relationships between researchers, extension workers and administrators defined. Likewise, there appears to be a good working relationship between the SAES director and the SEA/AR area director as well as between the station scientists and those employed by SEA/AR but working locally. Some concerns are as follows:

1. Some consumer critics insist that their voice is not always heard in the identification of priorities and the allocation of funds. Traditionally advisory groups have been those involved in agricultural production.

2. Affirmative actions procedures, even though necessary, cause prolonged delays in the employment of people. This is not to imply that SAES should not have strong affirmative actions programs.

3. The diffusion of responsibilities between the SAES director and the vice president for research sometimes leads to confusion and delays.

4. The trend toward applied research by extension personnel is of concern to both extension and research administrators. Extension leaders are concerned because of the loss of time from extension activities and research leaders are concerned that the research programs may not be completely integrated.

5. The lines of administration are awkward in instances where the SAES director is under the supervision of of the dean and/or vice president for agriculture but has responsibilities in forestry, home economics and veterinary medicine, whose deans report directly to the chancellor and/or president.

6. Department heads and SAES directors are concerned that SEA/AR researchers have separate budgets provided by Washington but the information not shared locally. This is not an universal complaint but it does occur.

7. OMB Form 21 is being expanded to include persons paid by Hatch funds. One university indicated it would cost $40,000 to meet the requirement. Universities cannot equate the partnership concept with the implementation of A-21. Additional record keeping only adds to the cost and frustration of the scientist and not to an effective use of his time.

8. The Hatch manual was originally a twenty-page document. Now it is five times that size. The Hatch Act has not changed -- only the requirements for qualifying.

9. Universities are very concerned with the complexities of compliance for all federal funds. Each federal agency seems to have a different set of guidelines for meeting compliance. The university has its own affirmative action and rules for dealing with minority groups. They ask why cannot a single affirmative action plan suffice for all.

10. University administrators are concerned with the great amount of time spent on grantsmanship. They believe a more efficient use of manpower would result from formula funding (Hatch) and less from grants and contracts.

11. The "animal rights" movement is of concern to experiment station workers. Several amendments to the Animal Welfare Act that are now pending before the Congress would constrain research in agriculture and human health.

12. The administration of Title V (Rural Development) has been a nuisance, to say the least, to station and extension directors. They report delays between passing of appropriations bill and request for plan of work. An excessive amount of paperwork and signatures are required for the small amount of money that is available.

B. Alternatives in SAES Management

The directors of SAES as well as members of their staff have adjusted to societal changes as they have occurred. Early programs were primarily concerned with testing -- testing of fertilizers, crop varieties, etc. In more recent times the scientists are concerned with "how corn grows" and not just "how to grow corn." Likewise they are devoting more attention to the quality of life, better nutrition, family problems and other social problems. Organizationally, however, they are faced with a dilemma. Graduate training is done by disciplines and yet problem solving is best accomplished by teams of scientists. No basic change in organization is suggested, but the following alternatives are offered in the spirit of meeting present societal needs:

1. A real effort be made to insure the continuation of the federal-state partnership in agricultural research. SAES directors should be willing to work positively toward such a goal.

2. Many SAES must either implement or expand their advisory groups to include more consumer viewpoints.

3. Research in veterinary medicine, forestry and home economics should be a part of the agricultural research program and clean-cut lines of responsibility be established.

4. The Hatch Act states clearly the functions of the director in terms of administering these federal funds. There has been a tendency for this responsibility to erode away with time. University administrators need to give attention to this development.

5. There should be enough assistant directors to bring about coordination of multidisciplinary research.

6. The roles of the dean (or vice president) for agriculture and the director should be sufficiently delineated so that each understands his functions.

7. A national study should be made on the new relationship between research and extension. The trend of more involvement in research by extension personnel with all of the pros and cons needs to be studied.

IV. THE SCIENCE AND EDUCATION ADMINISTRATION

The Science and Education Administration (SEA) was created by the United States Department of Agriculture in an attempt to improve coordination of research and extension at all levels of government, federal, state and county, as mandated in Title XIV of the Food and Agricultural Act of 1977. This legislation called for "building upon present partnership and cooperative arrangements and developing with all performers and supporters of food and agricultural research, extension and teaching activities. . . ." (7)

The legislation called for two advisory groups, namely, the Joint Council on Food and Agricultural Sciences and the National Agricultural Research and Extension Users Advisory Board. The Joint Council is composed of representatives from USDA agencies with research, extension and teaching responsibilities, the Office of Science and Technology Policy, Land-Grant Universities, state agricultural experiment stations, cooperative extension services, and other institutions, producers and the public. The Joint Council has organized regional councils that interact with the parent organization in setting priorities on research, extension and teaching activities that affect partners in the food and agriculture system.

The Users Advisory Board is made up of twenty-one citizens representing diverse food and agricultural views and interests from producers to consumers. The board prepares independent advisory views on priorities and the federal budget. It reports directly to the President, the Congress and the Secretary, but its reports are intended for the use of all research and extension agencies. It is staffed by, but independent of, SEA (4).

Although SEA was in response to Title XIV it includes what was the Agriculture Research Service (ARS), the Cooperative State Research Service (CSRS), the Extension Service and the National Agricultural Library. Additional responsibilities in the area of human nutrition, technical information systems, higher education and program management, planning and evaluation were assigned to it by the Secretary (Figure 1).

The functional units of SEA are:

1. Agricultural Research (originally ARS)
    a. Animal production and protection
    b. Plant production and protection
    c. Use and improvement of soil, air and water
    d. Processing, storage, distribution, food safety and consumer services

Science and Education Administration

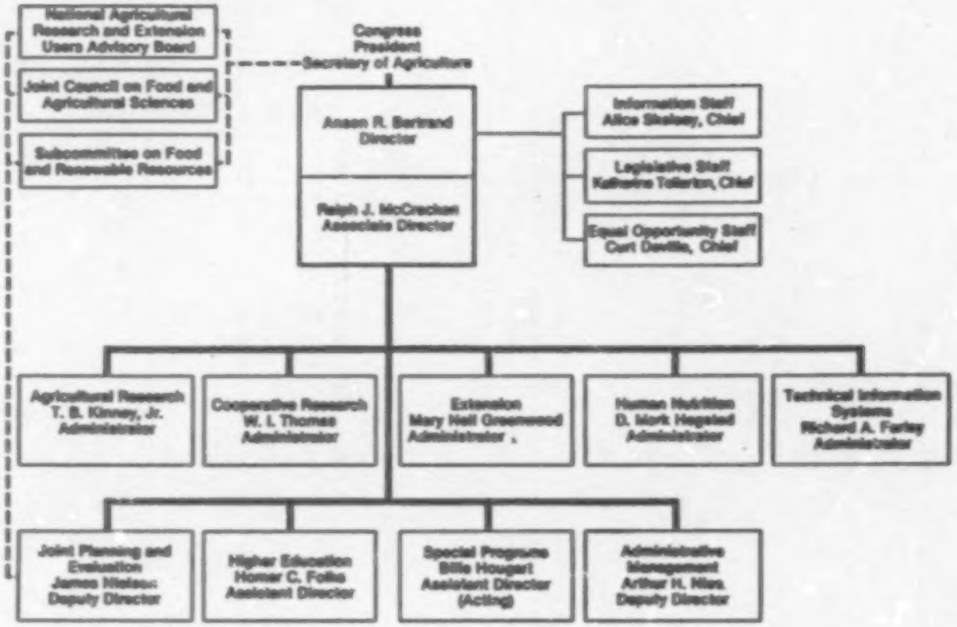
National Agricultural Research and Extension Users Advisory Board
Joint Council on Food and Agricultural Sciences
Subcommittee on Food and Renewable Resources
Congress
President
Secretary of Agriculture
Anson R. Bertrand
Director
Ralph J. McCracken
Associate Director
Information Staff
Alice Skelsey, Chief
Legislative Staff
Katherine Tollerton, Chief
Equal Opportunity Staff
Curt Deville, Chief
Agricultural Research
T. B. Kinney, Jr.
Administrator
Cooperative Research
W. I. Thomas
Administrator
Extension
Mary Nell Greenwood
Administrator
Human Nutrition
D. Mark Hegsted
Administrator
Technical Information Systems
Richard A. Farley
Administrator
Joint Planning and Evaluation
James Nielson
Deputy Director
Higher Education
Homer C. Folks
Assistant Director
Special Programs
Billie Hougart
Assistant Director
(Acting)
Administrative Management
Arthur H. Hiss
Deputy Director

FIGURE 1

2. Cooperative Research (originally CSRS)
    a. Payments under the Hatch Act
    b. Payments to Colleges of 1890 and Tuskegee Institute
    c. Cooperative forestry
    d. Competitive grants
    e. Special grants
    f. Animal health and disease research

3. Extension (originally ES)
    a. Payments under the Smith-Lever Act
    b. Payments to Colleges of 1890 and Tuskegee Institute
    c. Payments to the District of Columbia
    d. Rural development and small farm extension
    e. Food and human nutrition
    f. Federal administration and coordination

4. Technical Information Systems (originally National Agricultural Library)

5. Higher Education (transferred from HEW)

6. Human Nutrition
    a. Studies on effect of farm practices, handling and preparation of food nutrients
    b. Studies on reasons for food preference
    c. Nutrition Center for Aging at Tufts University
    d. Research on Methodology for Evaluating the Nutritional Status of the Population at the University of California
    e. Human Nutrition Research Center at Grand Forks, North Dakota
    f. Children's Nutrition Research Center at Baylor University

7. Joint Planning and Evaluation
    a. Program planning staff
    b. Program analysis staff

8. Special programs

A. Mechanisms of Planning and Coordination

SEA is a member of and participates in the Federal Coordinating Council for Science, Engineering and Technology. Areas of responsibility include human nutrition (also in HEW), water (Interior) and fisheries (Interior and Commerce).

The Director of SEA wears two hats. He is equivalent to an assistant secretary, reports directly to the Secretary and is the science and education advisor to the Secretary. He is also the chief executive officer of an operating agency. He is the chairman of the Department's research program including ESCS, FS, SCS, AMS (wholesale marketing and packaging), OICD and Office of Transportation.

Internal SEA decisions are made by the Director and Associate Director in consultation with the Management Team. The team consists of the heads of AR, CR, ES, Human Nutrition, Technical Information, Joint Planning and Evaluation, Higher Education, Special Program and Administrative Management. In addition, representatives of sub-units usually attend as non-voting but often participating members. In reality, therefore, more than the above eleven attend. The management team's function is to provide coordination and establish policy that affects the sub-units. To date, one of their main activities has been related to budget preparation.

1. Joint Planning and Evaluation (JPE)

The JPE provides the staff for the Joint Council on Food and Agricultural Sciences and National Agricultural Research and Extension Users Advisory Board, each headed by an executive Secretary. A second major unit is the Program Analysis Staff whose function is to cooperate with federal departments and agencies, the state colleges and universities, other science and education organizations, and other user groups in developing effective joint programs to meet high priority research, extension and teaching needs. They are also expected to assess economics, social and other impacts of federal and non-federal research, extension and teaching including past, current and future programs.

A third major unit is the Program Planning Staff (PPS). Its major role is to help develop an integrated budget for SEA. The basic structure for budget building consists of fifteen decision units, primarily commodities, and spcial analysis for specific subjects as basic research, energy, etc. A typical decision unit is made up of three to five members, the chairman from PPS, one from CR, one from ES and the remainder from AR. They are expected to make budget recommendations to the SEA Management Team.

The large PPS staff is made up of people recruited from within USDA, primarily AR, recruited from the outside, personnel on detail from AR, CR, ES, and a significant number of university people serving in a temporary capacity under the Intergovernmental Personnel Act (IPA). The rationale for detailing people from AR, CR, ES, etc. is that they will get training in making analyses and budget preparation that will be useful when they return to their home units. Presumably the same rationale would apply to university recruits. However, the operating heads of a number of the agencies making up SEA complain that too many of their scarce personnel ceilings and some of their key researchers have been taken to staff PPS. They agree that PPS is doing excellent staff work, but at the expense of the administration of ongoing programs.

2. Special Programs

This unit is designed to give special emphasis to science, education and extension initiatives through the use of program managers. Attention is being given to establishing energy centers for help of farmers and ranchers. Likewise an acquaculture center is being established. Apparently little has been accomplished to date.

3. Human Nutrition

The USDA has a policy committee on nutrition consisting of several assistant secretaries and other people in positions of authority. The director of human nutrition is a member of the committee. The director meets monthly with the nutrition leaders within SEA and other agencies within the USDA. There is also one employee that spends half time in the PPS, thus acting as a liaison between Human Nutrition and PPS.

4. Administrative Management

This is the business office for SEA, including the agencies that were folded into it. All fiscal, personnel and business activities for the agency are handled by the unit. Most of the staff were former empoyees of AR, with a small number coming from CR and ES.

5. Agricultural Research (AR)

Below the Administrator's level, AR still functions as it did under the reorganization plan of 1972. At that time, the agency was divided into four regions headed by a regional administrator who is located within the region. The Administrator is a member of the SEA Management Team. The National Program Staff (NPS) of AR serves as subject matter consultants to AR scientists throughout the country and to the office of the Administrator. Present plans are for them to spend more time consulting with scientists and less time as staff people to the Administrator. AR prepares its own budget from information obtained from its four regions and its NPS. The AR budget is then integrated into the SEA budget. At that point AR has no more control over what goes into the USDA research budget that is submitted to OMB and the Congress.

Each of the four AR offices is headed by a regional administrator with a supporting cast of program planners and fiscal officers. Their budget is prepared from information obtained from the area director, the AR/NPS, scientists, professional meetings and public hearings. The regional administrators meet two to three times annually with the SAES directors on program planning and cooperation.

The four AR regions are broken down into areas, headed by an area director. The director works with the AR scientists within his region and is also in close contact with the university department heads and SAES directors. He depends upon the NPS for subject matter guidance and to the regional administrator for policy decisions. Area budgets are controlled in the regional office. Mini-conferences between the AR area director and the SAES directors within the region are held regularly for purposes of cooperation between federal and state programs. The regional administrator and his program staff attend. The approach seems to be effective. However, staff members of some of the laboratories have complained that the area directors is simply one more administrative layer to work through in order to reach major decisions, most of which seem to be passed upon in Washington.

Within the area most of the AR scientists, but not all, are located on Land-Grant University campuses. They are located within the university departments and interact daily with their related local associates. Program-wise, they are completely integrated into the university program. Their relationship to the department head, the area director, and their research associates by long tradition is completely understood. It is an excellent working relationship and represents program planning at its best.

6. Cooperative Research (CR)

The Administrator of CR is a member of the SEA Management Team and is responsible for administering the federal funds that go to the states for research in agriculture, forestry, animal health, and nutrition. Traditionally CR has developed a close working relationship with the SAES, the schools of forestry and the colleges of 1890. Many of the staff were former scientists at these universities.

The Administrator is a member of the Experiment Station Committee on Organizations and Policy (ESCOP) and meets regularly with them on research matters of interest to the states and to the USDA. Likewise he meets with a similar board created with the passage of the McIntire-Stennis Act providing funds for forestry research at the forestry schools. Their functions are to advise the Secretary on priority needs in forestry and to administer funds under the formula funding. These two forestry committees, the Cooperative Forestry Research Advisory Committee and the Cooperative Forestry Research Advisory Board, are effective mechanisms for encouraging cooperation among the states and between the states and the Forest Service.

As a part of the CR staff's responsibilities toward coordination of research among the states and between the states of the USDA, they participate in many conferences in Washington on behalf of the states. CR could be far more effective than it is if permitted to do so by the SAES directors. The Hatch Act amended gives the Secretary of Agriculture broad powers and responsiblities in administering the funds to the states. CR performs these functions on behalf of the secretary. Unfortunately the SAES directors have never been willing to fully utilize CR in terms of the agency being its Washington representative. In the name of states rights they have prevented CR from performing many functions that would be of assistance to their own programs. CR needs more control and authority in dealing with the states.

In addition, they conduct systematic subject matter reviews in all of the states. These reviews include not only research funded by Hatch or grant funds, but by mutual consent, all of the research, regardless of the source of funding. Review teams include outside experts from other universities as well as from the USDA. At the close of the review they report to the scientists, department head and SAES director. This has proven to be a very effective method of evaluating research and includes the local USDA research program. Unfortunately a few station directors have never fully utilized this review process. The fact that some state programs are better organized and more effective than others is, in part, due to this discrepancy in utilizing the system.

Historically all Hatch-supported projects have been transmitted to CR for review and approval or disapproval. By mutual consent between CR and the SAES directors all state-supported projects are also transmitted to CR for their information. Thus the CR staff is knowledgeable of all activities at the state level. This desk project review process is not always productive. Some SAES directors transmit good outlines; some do not. Some CR staff members make excellent contributions to the outlines; others do not.

Peer reviews for all grants, competitive research grants that are available to all scientists and special research grants under PL 89-106, are conducted by the staff, with the assistance of outside scientists. The actual sign-off is made by the Director of SEA upon the recommendation of the CR Administrator. This, of course, adds one more administrative layer as compared with operations before the creation of SEA.

The CR staf is also charged with the responsibility of developing a budget that reflects the state inputs from ESCOP and the Directors-At-Large (representatives of the four Experiment Station Directors Association). The budget is then integrated into the SEA budget. At that point CR has no more control over what goes into the USDA research budget that is submitted to OMB and the Congress. Furthermore, much of the CR staff time is spent in preparing the SEA budget under the supervision of PPS.

The functions outlined above also apply to CR relationships with the Land-Grant Colleges of 1890 and Tuskegee Institute. Although funding for them is earmarked, the method of project proposal is a mechanism somewhat between formula funding and grant proposals. One staff member recruited from an 1890 college is responsible for coordination among the 1890 institutions and between them and the SAES.

The relationship between the Land-Grant Universities of 1862 and 1890 varies from state to state. Prior to 1970 the role of the 1890 institutions was primarily teaching. Since that time, Congress has appropriated funds for research and CR has encouraged collaboration between the two within a particular state. The results have been only partially successful. CR has insisted on agreements between the two so that a division of labor could be spelled out. All three parties, the two Land-Grant Institutions and CR, need to give more attention to this aspect of research coordination.

Section 3 (c) 3 of the Hatch Act provides that up to twenty-five percent of the funds may be used for regional research to "stimulate and facilitate inter-state cooperation on research of a regional and national character both among SAES and with the United States Department of Agriculture" (3). CR has been delegated the responsibility for administering these funds. Advisory to CR is the Committee of Nine, a committee specified in the law to include eight SAES directors and one home economics research administrator. The concept is an excellent one and has resulted in much regional cooperation not feasible for a single state.

B. Constraints

SEA

1. The newly formed organization is still struggling with its organization. The large staff assembled for budget making, planning and evaluation appears to be excessive, with much duplication of effort in the budget-making process between the sub-units (AR, CR, etc.) and the PPS.

2. A better coordinating mechanism is needed between the USDA/SEA and HEW in nutrition research and USDA/SEA and Interior on water and fisheries research. Apparently such developments are in the making.

3. Director and Associate Director are concerned with too many details, resulting in unnecessary delays. The Director and Associate Director seemed to be concerned with many details of the day-to-day operation. Their talents could best be directed toward policy matters.

AR

1. The stress of arriving at budgetary recommendations for SEA has made it difficult for representatives of AR, CR, and ES. Reportedly, cooperation has deteriorated rather than increased under the new organization.

2. NPS has been reduced in number while PPS has expanded, making it much more difficult for AR to perform duties expected of it.

3. With the reduction of travel budgets, the NPS has not been able to visit field stations, attend scientific meetings or perform other travel considered essential in the performance of their duties.

4. Another layer of administration has caused delays. Many decisions formerly made by the administrator must now be reviewed by him and forwarded to the Director for final approval.

5. Personnel policies have not been stabilized. In the early part of the 1980 calendar year, they were advised of a reduction. Then field staff was given permission to fill four of ten vacancies. Later they were given permission to hire without regard to ceilings!

6. Field staff sees little relationship between their inputs in budget requests and what goes to the Office of Management of Budget and Congress.

CR

1. CR is the thread in the partnership between the USDA and the states. The current philosophy in SEA (not by the Director, but in his support staff) is putting the partnership concept to a real test. More dialogue is needed before major decsions are made that affect the research at the SAES.

2. Efficiency is not always correlated with size. The pooling of all fiscal matters in one office has caused great delays. Example -- one year to hire a scientist; four to five months to hire a secretary. The same delays are evident in procurement. Furthermore, state people experience delays and frustrations in being unable to contact the proper person or being able to contact someone familiar with state research programs and procedures.

3. Policy matters have been centralized to the point of creating unnecessary delays. Example -- the Director of SEA rather than the Administrator signs off on all grant proposals.

4. Administrative regulations result in added work and unnecessary delays. Example -- administrative manual for Cooperative Agricultural Research (the Hatch Act) was twenty pages but now four to five times that large with no change in the law.

5. The detailing of staff to PPS for developing integrated budget is reducing their capability to perform necessary functions in coordinating agricultural research among the states. The subject matter specialist considers his twelve months with PPS as essentially a "lost" year in his professional life.

6. The concept of regional research as provided in the Hatch Act has never been fully exploited. The SAES directors have never been willing to give the Committee of Nine the authority to make bold but necessary decisions. At the same time the method of funding has resulted in limited enthusiasm on the part of scientists because the financial incentives have been eliminated.

7. The budget inputs from CR and EXCOP are so diluted that they reflect little resemblance to the budget approval by the Secretary, OMB and submitted to the Congress. If the partnership concept is to survive, both sides must be given equal hearings.

8. The development of an integrated budget in which CR staff participates as minor voters places them in a compromising and embarrassing position. The smaller agencies such as CR and ES often have only one representative on a committee that makes budgetary recommendations that affect both the USDA and the fifty states. Taxation without representation was settled in 1776!

9. Historically the CR has perhaps made its greatest contribution toward coordinating agricultural research through its institutional reviews. There is real concern that this function may be absorbed by the JPE. These reviews are jointly planned by the CR staff and the institution to be reviewed. Most of the participants are the very top people in their particular field and are recruited without salary from the universities and AR or ESCS.

10. Station directors and the USDA ne[illegible] to recognize that CR has a far greater potential for serving their constituents, the states, if given more authority and responsibility.

Human Nutrition

1. Needs a better definition of allocation of functions between Human Nutrition (SEA) and Nutrition (HEW). Obviously this is a difficult problem because nutrition is defined differently by different agencies.

2. Personnel slots are needed to staff present centers that have been authorized by Congress. Some of the recently activated nutrition centers are creatures of Congress without provision for the necessary personnel.

C. Alternatives in SEA Management

The Congress is to be congratulated in the passage of Title XIV -- National Agricultural Research, Extension and Teaching Policy Act of 1977. The act designates the USDA as the agency of the federal government for agricultural research (except for biomedical aspects of human nutrition), extension and teaching in the Food and Agricultural Sciences. Partially in response to the legislation the USDA has created SEA to focus attention on the coordination of these three functions. The architects of the agency feel they have increased the creditability of research in the USDA, OMB, and the White House. They also feel they have done an outstanding job in developing an integrated budget under the zero budget concept.

In interviewing people within the Department, as well as university people, the writer gained the impression that the Director of SEA is held in high esteem, a good job is being done in budget preparation but at enormous manpower expense, and that progress is being made in the two advisory committees. Little progress seems to have been accomplished in long-range planning. in expediting decisionmaking, and furthermore morale is low in the sub-agencies because of heavy drain on their limited personnel, thus preventing them from performing their necessary functions. The university half of the partnership concept is in disarray. They no longer see themselves as a viable and functional partner.

The following alternatives are suggested.

1. The SEA Management Team should consist of the Director, Associate Director and the Administrators only and function as a policy board. Many of the operation details should be left to the Administrators.

2. The budget-making process should be greatly simplified. Presently much time is spent in developing an integrated budget for the Secretary and OMB after which AR and CR present their individual budgets to the Congress. Too much manpower is borrowed from the agencies in the budget-making process.

3. The concept of the Interregional Project would appear to be a logical one in getting state inputs into the budget-making process. It should be supported. Interregional Project 6 was designed as a mechanism for state inputs into the SEA budget but the support has been inadequate.

4. More autonomy given to the Administrators of AR, CR, and ES, thus expediting decisionmaking at all levels.

5. Placing competent and sympathetic personnel in the Administrative Management section for expediting decisionmaking and improving morale. Too many of the present personnel have no understanding of state problems and give the impression of little sympathy toward their solutions.

6. Begin a renewed effort at all levels to rebuild the partnership concept that has been nearly one hundred years in the building. Many of the SEA support staff have no experience in dealing with research matters affecting the states. Likewise there has developed a distrust of them by state personnel.

7. Cooperative regional research as provided in Section 3 (c) 3 of the Hatch Act could become a much more meaningful approach to the solution of regional problems provided the SAES directors and SEA were committed to fully exploiting the intent of the Act.

8. The NPS of AR needs to be strengthened both in terms of numbers as well as quality. They should command the respect of their peers throughout the community of their disciplines. Currently this is not true. A competent NPS would do much to correct the deficiencies of the present AR organization.

V. THE ECONOMICS, STATISTICS, AND COOPERATIVES SERVICES

The Economics, Statistics, and Cooperatives Services (ESCS) is probably the largest single producer of economic and statistical information in the world and thereby a major component of the United States and world agriculture and rural information system (1).

ESCS priorities are set after advice and counsel from many in and outside the USDA. They meet with leaders of the economics profession, farm organizations, congressional staff and consumer groups. The Administrator is a member of the Joint Council on Food and Agricultural Sciences. Members of the staff participate in studies of the National Agricultural Research and Extension Users Advisory Board. The Administrator meets with the USDA assistant secretaries and agency heads that have allied interest.

It has become evident over the years that there is no single most effective way to organize economic research. Thus any reorganization could meet particular needs at a particular time. One purpose of the 1979 reorganization was to rationalize internal organization by replacing program areas with fewer branches and by strengthening the branch leadership. The need to do both seemed obvious. The Deputy Administrator asked some fourteen high-ranking leaders to request reductions in grade in furtherance of the reorganization. Only two such reduction resulted but many of the former leaders transferred or retired. There was an unexpected ripple effect from this attempt to reduce some people in grade in that many able younger economists also transferred to other agencies.

One result of this reorganization and the almost total change in branch leadership was that the research efforts were confused for probably several months. The situation was further complicated by a forced continued reduction in the number of personnel that could be employed by ESCS. However, by 1980 most of the persons who had been adversely affected by the reorganization had left or had adapted to the new circumstances.

With the declining number of research people available because of lower personnel ceilings and a continuing pressure for policy analysis, there is less research being done in a number of areas such as finance, inputs, marketing and commodity outlook. At the same time, there would appear to be a strong base upon which a vital, effective Economics and Statistics Service could be built.

Unlike AR, most of the economics research staff is located in Washington. Generally speaking, the ESCS economists are engaged in staff analysis, integrators of economic information, and national international economic problems. Economic research at the universities tends to be more toward generating new information and more on methodology. There appears to be a good working relationship between Washington ESCS and the Departments of Agricultural Economics at the Land-Grant Universities. Where ESCS people are located on campuses, a division of labor has been clearly established. Most policy matters are handled by the ESCS Administrator, or his representative, and the Head of the Agricultural Economics Department rather than with the SAES Director.

Land-Grant Unviersity people, and especially SAES directors and heads of agricultural economics departments, would prefer that more of the ESCS staff be located on campuses as is true with AR. The trend has been in the other direction and continues to be under the present administration. Presumably one rationale is that they are needed to be closer at hand in order to be more responsive to the needs of the Secretary.

Another criticism stems from the above situation, i.e., the need to spend so much time putting out fires at the expense of economics research. Such functions as economic analyses and integration of economic information may meet the political and economic needs of the Secretary, but it can hardly be called research. As a result, ESCS is no longer the home of a world-famous collection of agricultural economists as in the days of the Bureau of Agricultural Economics. There is serious doubt that the present agency can attract or retain the truly great economic scholars that are being trained and entering the job market.

VI. GENERAL STATEMENT OF RESEARCH PLANNING (Prepared by Mark T. Buchanan)

A. Description

The Regional and National Agricultural Research Planning and Implementation System is being continued and improved. This research planning process, begun under the auspices of Agricultural Research Policy Council (ARPAC), is being continued by the Interim National Research Planning Committee of the Joint Council.

In keeping with the original plan, flexibility is maintained to permit the incorporation of needed improvements and of innovations. Under the Joint Council's auspices, these have included rescheduling of activities better to interface with state and federal budgetary processes; the inclusion of representatives of additional research performers, users and the public; and the provision of additional staff assistance.

The research planning process includes two major, interacting components: (1) Task forces, regional and national, with staff assistance, comprised of scientists selected by their peers to examine, in-depth, research needs and priorities within program areas identified as being currently most significant and most in need of additional research effort. These program areas are selected from among areas that comprise the total spectrum of existing and needed research.
(2) Projections by research administrators (state and federal) of their perceptions of priorities within two levels of assumed, real resources -- no increase, and twenty percent increase. The administrators thus constrained must respond in a systematic way, i.e., with consideration of all research elements. At the zero level, for example, proposed increases must be offset with decreases.

Interaction among scientists and administrators is encouraged before, during and following projections.

Once the projections are in and aggregated regionally and nationally, a meeting of administrators and scientists is held in each region. Each will have had a chance, meanwhile, to study the aggregations and preliminary analyses. At this meeting, there is also additional discussion concerning high-priority areas for increasing research emphasis. At and following this meeting, research administrators may change their projections based on the recommendations of the scientists, on the basis of the information exchanged, or for other reasons.

B. Evaluation

Meetings of ad hoc Regional Councils have been held under the auspices of the Steering Committee of the Joint Council to discuss the means by which the Joint Council may best continue to meet its mandate "to foster research planning and coordination." The consensus of all four regions is to continue and to build upon the present process.

The process does an excellent job of determining research needs and priorities as perceived by the scientists and administrators who are key elements of research performers. Needs as perceived by industry and other users and by representatives of the public are considered in the iterative process; representatives of these groups are members of Regional Planning Committees. It could be argued, however, that the input of these groups could be strengthened.

The most significant weakness of the planning system is that it does not have a direct tie to the budget process. There are two ways in which this is disadvantageous:

1. While the system identifies needs and priorities, it does not determine which performer could best do the work. It does not address the distribution of support among performers.
2. As the Federal Budget Process works, the planning results become only one of many factors taken into account. The results of the planning process do not appear to have sufficient "political clout," to make a major impact,

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Commissioned Paper III

INCENTIVES AND DISINCENTIVES IMPORTANT TO RESEARCH MANAGEMENT AND ADMINISTRATION

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Office of Technology Assessment

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Glossary

ARS - Agricultural Research Service

CSRS - Cooperative State Research Service

ERS - Economic Research Service

FY - Fiscal Year

GNP - Gross National Product

NMOR - Nonmission Oriented Research

NSF - National Science Foundation

OMB - Office of Management and Budget

OSTP - Office of Science and Technology Policy

P.L. - Public Law

RANN - Research Applied to National Needs (NSF)

R&D - Research and Development

SAES - State Agricultural Experiment Station(s)

SEA - Science and Education Administration

SEA-AR - Science and Education Administration - Agricultural Research

SEA-CR - Science and Education Administration - Cooperative Research

USDA - United States Department of Agriculture

Agricultural Research System--a federated system of research involving cooperation and full partnership responsibilities of research managers and scientists from federal, state, and private institutions in the planning, funding, implementation and conduct of investigations on agricultural systems, problems, issues, commodities, resources, missions, biological phenomena, or other researchable entities or processes.

I. Summary

Incentives and disincentives are relative forces that enhance or discourage people and their organizations to carry out their responsibilities. They become part of the processes that occur between federal legislative, policy, program, and budgetary actions and the intended impacts of their actions.

This article attempts to identify disparities between intended outcomes of federal initiatives in agricultural research and actual outcomes, and some of the causes of these disparities that have been perceived by performing individuals, groups and organizations responsible for research to meet the needs of American agriculture. Many of the disparities were intensified by insufficient incentives or presence of undesirable disincentives or both, and have resulted in strong discontents and deterrents that detracted from research effectiveness.

We have emphasized the effects of incentives and disincentives on the effectiveness of research in serving American agriculture in the broad sense. Now that Congress has given the U.S. Department of Agriculture (USDA) the lead role in agricultural research, we believe the USDA is obligated to interact with the total agricultural research effort, especially that which is publicly supported.

Our recommendations are based on the assumption that the needs of the Nation for Agriculture and its outputs will continue to intensify in the near future. Further progress in agriculture will depend more than ever on improved technologies and processes made possible by research. Therefore, the USDA, as the "lead agency of the Federal Government", can improve the influence of the national leadership if it can effectively assess, with the help of expertise outside the Federal government, the totality of needs and opportunities in American agriculture that can be met through research and can stimulate as well as direct initiatives to translate the assessments into useful contributions. Thus, we draw a distinction between national influence and Federal control.

We believe that accomplishment of such a comprehensive leadership role will require more sophisticated approaches and policies than in the past.

First of all, the relative importance of agricultural research should be judged more in terms of its effects on a production agriculture that generates over $100 billion annually in receipts at the farm gate and makes possible a value at the consumption and exporting ends of two to three times that figure, instead of limiting its view to the federal base of support for agricultural research. Interactions of agriculture with the environment, consumers, etc. and the welfare of persons in agriculture will continue to deserve substantial research attention also.

The Congress has recognized expertise and capabilities beyond the USDA. The Congress states in its findings (Sec. 1402 (a), P.L. 95-113) "the existing agricultural research system consisting of the Federal Government, the land-grant colleges and universities, other college and universities engaged in agricultural research, the agricultural experiment stations, and the private sector constitute an essential national resource which must serve as the foundation for any further strengthening of agricultural research in the United States."

The relative research importance of those groups and the nature of their contributions to agriculture must be considered also. Within the federal government, the U.S. Department of Agriculture is most important to agricultural research. Within the other groupings, the State agricultural experiment stations, who conduct over 60 percent of all publicly supported agricultural research is most significant. Private industry, conducting over half of all agricultural research and development is very important to American agriculture but in ways different from research that is publicly supported. Private industry concentrates their R&D mostly in the improvement of purchased inputs to production agriculture and to improve processes and products beyond farm gates. The profit motive becomes a logical guide to their priorities. However, R&D in the private agricultural sector is becoming increasingly sophisticated and comprehensive, especially in the larger agricultural companies.

If the USDA is to provide overall leadership for agricultural research it must improve its interactions with the 60 percent of publicly supported research carried out by state research leaders which is paid for mostly by appropriations from state legislatures. And the USDA - State collaborative processes should include, where appropriate, R&D leadership in agricultural industries. The USDA must deploy its own research resources on logics developed interactively with the States as well as on the logics of its inhouse research agencies if American agriculture is to be maximally served through the use of State and Federal tax dollars for research. Therefore, we believe that coordination, which Congress emphasizes because agriculture needs it, should become an increasing component of USDA leadership.

Improved USDA leadership will require experience in the agricultural research process at the Secretarial level. For the same basic reasons that Bell Laboratories is led by a capable research leader who determines policies and directs programs in their $1.6 billion level of R&D operations, so must there be the same fundamental capabilities of leadership for agricultural research at the policy level of the Secretary's office. History has shown recently and throughout the years that the effectiveness of USDA leadership is a direct outcome of research leadership capabilities and understandings at the Secretarial level.

Therefore, some of the recommendations we have listed first become, in our view, important if not necessary prerequisites for those to follow.

There are some "prerequisite" deterrents to agricultural research which have proved to be important to understand within the context of incentives and disincentives to that system, but for which we have not made specific recommendations.

The greatest contributor to discontent appeared to be the lack of size of appropriations for agricultural research. The concerns in the leadership of the agricultural research community, USDA and state, have become most intense in two categories.

1. Lack of growth in size of programs because of inflation coupled with requirements for new programs. Inflationary effects have been intensified because agricultural research has had to extend its resources into new areas, increase its "defensive" research (to help agriculture cope with government regulations) and to increase its basic research. Less resources than before are now available for research to increase productivity of American agriculture. In USDA, personnel reductions have further reduced their resources available for research.

2. Small size of agricultural research in comparison to other federal government programs. This has caused the Executive Branch to apply organizational logic and rules, regulations and procedures developed for larger Federal action and regulatory agencies and for research grant and contract processes and subsume agricultural research under these categories without checking further on how well they fit.

It is not surprising that the Congressionally intended operational logic of a Hatch research program funded at a little over $0.1 billion should not be considered separately in a total Federal R&D annual extramural outlay of $13 - 14 billion or a total Federal investment over $41 billion in R&D. It is of concern, however, that consistency of Federal procedures and rules should arbitrarily be given precedence over the exceptions needed to accomplish Congressional intents expressed in the enabling legislation.

The paper endeavors to show that the primary reasons for exceptions to government-wide generalized regulations and procedures are tied to the dispersed, complex and variable nature of American agriculture and the twin requirements of a research system to serve the needs of that agriculture and for acquisition of new knowledge and understandings.

Operationally, we believe that Congress must make the exceptions through legislation, if they are justified. The people in the Federal government who generally insist on total compliance with their regulations are so remote from agricultural research programs that it is very difficult to effect change by formal petititon by the Secretary of Agriculture or through negotiation by lesser individuals.

One of these dilemmas to research administrators has resulted in the past from disagreements between leaders of the Congress and leaders of the Administration and insufficient recognition of priorities and needs perceived by important leaders of American agriculture.

The research leaders in the USDA should be and have been sensitive and responsive to the desires and demands of Congress and of political appointees in the Executive Branch. The in-house programs are usually examined in more detail than the USDA-State partnership programs because the former group (ARS, ERS and FS Research) were centrally organized and totally federal.

The in-house research agencies of the USDA have little difficulty in responding to federal concensus priorities--those needs seen similarly as important by the Congress, by the Executive Branch and by leaders in agriculture. The dilemma of the USDA research administrators grows when there is serious disagreement between the two branches of government and between them and agricultural leaders throughout the country. The USDA research leaders really can't choose; they must respond to all three. As resources, financial and personnel, become more limited or even reduced, the result is lessened or lost flexibility in the administration of the programs. All of the flexibilities become used to meeting demands or desires of leaders with superior political power. The peril of denying a Congressional or Executive priority is too great. There is also peril in denying a carefully thought out and important priority being pushed vigorously by leaders of important segments of American agriculture. We find it difficult if not impossible to formulate a recommendation to clear the dilemma. All of those leadership entities should and do have the right to influence the course and purpose of federally funded programs. However, we do believe it is important to surface this important dimension.

The importance of maintaining strength, a full spectrum of required expertise, and flexibility for change and interaction in the in-house research agencies of the USDA is described.

Since most of agriculture is both "supra-state" and "sub-national", it becomes important that the USDA in-house research agencies coordinate their programs with the states and use their resources to stimulate coordination among the states as dictated by the characteristics and needs of the agriculture being served. The importance to agriculture that all major interactions between the USDA and state agricultural research leaders be on a partnership basis is described.

The long-range characteristics of much of agricultural research are highlighted first because past events have shown that agricultural advances are dependent on continuing research involvement. Grants and contracts have hastened the development of good research ideas and are thus effective complements to the basic programs. They are also a good means of soliciting scientific research outside the agricultural research system to meet special needs. However, there is little evidence that spot funding through those mechanisms can replace needed long-range viability of base research programs. This appears to be as true for the large industrial laboratories as for publicly supported agricultural research.

Some of the recommendations refer to universities, particularly those which are parent institutions for the state agricultural experiment stations. Their procedures and policies must permit the state stations to carry out their obligations to meet needs of their state's agriculture through research--not just carry out scientific projects that are agricultural. We urge that parent universities include recognition of service to agriculture along with contributions to scientific understandings as they apply their reward systems to agricultural experiment station scientists. We also urge that they recognize the values of partnership activities among the state stations and between their own station and the USDA.

Some of the recommendations to improve relevance of federal procedural requirements to research program characteristics have important connotations to the university. Whether an interaction between the USDA and a state agricultural experiment station be through a cooperative agreement for special programs or through the more comprehensive partnership of the Hatch Act, it is important that the parent university recognizes and respects the partnership intent. However, if the procedural and financial processes prescribed federally are in the federal procurement mode, the higher officials of the university are apt to treat the program similarly at its end, particularly if they gain more funds for university operations in the process.

The agricultural scientific societies are also mentioned, primarily because they can contribute more than they have in the past. They represent one of the best means to obtain collectively scientific advice and reactions on important agricultural needs and to suggest and appraise new and expanded opportunities that joins scientific feasibility with agricultural usefulness.

Up to now, scientists have been very reluctant to go beyond their own internal scientific affairs. The risks or penalties for entering what they perceive to be the "political" arena are seen by them as too great. Hence those perceptions of risks become disincentives that prevent our obtaining their expert judgement on many issues.

The more that scientific advocates or strident critics commandeer media attention, the more the government needs to seek the views of those scientists who are more objective and analytical.

Our recommendations are summarized here.

- Insure that at least one of the persons at the Assistant Secretary level or equivalent in USDA is highly knowledgeable of agricultural research and the realities of its interactions with American agriculture, retrospectively and prospectively.
- Improve forecasting and assessments of changes in agricultural research.
- Improve understanding of needs and opportunities in American agriculture that can be met by research and extension alone and what will require interactions with other forces of the private sectors, government and nature.
- Adopt credible procedures to sense and assess the changing profiles of private R&D and to solicit recommendations, perceptions and priority reactions from industry to enhance effectiveness of publicly supported agrucultural research.

- Follow for publicly supported agricultural research the model of research and development of the larger industrial corporations that combines the integrity of useful purpose with the quality of research in question.

- Encourage leaders from agricultural R&D organizations to participate in planning and program improvement processes.

- Encourage a greater commitment of federal funds for support of agricultural R&D commensurate with increased expectations of agricultural research and inflationary costs.

- Achieve a more realistic balance between long-range and short-range needs for research.

- Improve understanding and appreciation of the responsibility of the SAES to the agriculture of the state and to its primary funding source, the state legislature.

- Improve the recognizability of the SAES needs in budget and appropriation processes at state (parent university and state government) and federal levels.

- Encourage improved partnership processes among the states and between the states and the USDA and remove disincentives to improved effectiveness.

- Utilize selective funding processes so that some of them can enhance the USDA-state partnership efforts.

- Avoid complete partitioning of USDA-Federal research purposes from those of the states.

- Examine major programs, procedures and financial accountability forces and make appropriate changes to assure that individually, interactively, or aggregatively they are not deterring effective research implementation and performance.

- Allow agricultural research managers, USDA and state, sufficient flexibility to deploy their resources to maximize their effective use.

- Guard against expanding federal agricultural contract and grant funds at the expense of inhouse research programs.

- Maintain a sufficiently strong multi-disciplinary core of federal food and agriculture inhouse scientists to assure effective surveillance and coordination of the extramurally funded research, and to provide for a continuum of effective federal research programs on high priority national and regional research missions and problems.

- Encourage early lead-time interactivity on a mutual support basis between government action and regulatory agencies and research institutions and agencies, especially where their interaction can serve common purposes.

- Examine regionality in a more comprehensive sense so that agricultural commonalities across state boundaries can be more effectively dealt with by the state and USDA research.

- Seek improvement of federal funding and administrative procedures to reduce incompatabilities between SAES responsibilities to their own states and their accountabilities to important segments of the federal government.

- Avoid substitution of federal for state funds.

- Improve utilization of peer influence processes in planning and carrying out agricultural research.

- Involve professional societies to help identify and encourage scientists to participate on committees, to prepare analysis and status papers and to assess scientific feasibilities.

- Encourage professional societies to foster intersociety activities which contribute to agricultural research planning, and processes and to utilization of the outcomes.

II. Introduction

The purpose of this paper is to analyze and discuss the intents and actions of governments, state and federal, as they influence research to serve the needs of agriculture throughout the United States.

We do not propose to criticize intents of public leaders in government or the universities. History makes it clear that they have acted sincerely in the public interest with few exceptions.

History has also shown, however, that important disparities have occurred between intents and the impacts of government and university actions and policies on the effectiveness of research institutions and their processes in serving the needs of a complex and variable agriculture. This paper will identify those disparities, some of their causes and suggest remedies.

The Congress has reaffirmed its faith in the overall system of agricultural research and the constituent institutions. The Congress documented their reaffirmation in Title XIV, P.L. 95-113, by stating "the existing agricultural research system consisting of the Federal Government, the Land-Grant colleges and universities, other colleges and universities engaged in agricultural research, the agricultural experiment stations, and the private sector constitute an essential national resource which must serve as the foundation for any further strengthening of agricultural research in the United States." (Sec. 1402(9))

The Congress also identified needed improvements. Some of the improvements Congress listed are applicable to existing programs and institutions (improved coordination, responding more effectively "to the needs of all persons affected by their research", and improving effectiveness of transfer of research information).

The Congress also emphasized that the "rising demand for food and fiber", the need to avoid food shortages caused by climatic adversities, and inadequencies of the marketing system will require expansion as well as improvement of agricultural research and extension.

The Congress also listed new Federal initiatives that are needed. Their list included research to find alternatives to technologies based on fossil fuels; human nutrition; solutions to environmental problems caused by changes in agricultural technologies; aquaculture; improve use of natural resources; home economics; deal more effectively with problems of climate, weather modification and drought; strengthen family farms with special emphasis on small farmers; expand exports of agricultural products; improve utilization of waste products; expand programs in animal health; develop new crops; and seek ways to use organic materials more effective. (Sec. 1402(8)).

For old and new programs the Congress stated that "a strong research effort in the basic sciences is necessary to achieve breakthroughs in knowledge that can support new and innovative food and agricultural technologies".

Most importantly, the Congress recognized that expanded research programs require additional funding by stating, "Federal funding levels for agricultural research and extension in recent years has not been commensurate with needs stemming from changes in United States agricultural practices and the world food and agricultural situation". (Sec. 1402(7)).

Recent studies of agricultural research by other groups have reached conclusions consistent with the findings of the Congress. For example, the World Food and Nutrition Study completed in 1977 under the auspices of the National Academy of Sciences states, in part, "Our first set of recommendations concerns the federal-state agricultural reseach system and the role of the Department of Agriculture (USDA). We consider these recommendations to be the most important we are making on organization and financing". (Underlining ours. (page 18 (1).

The study report goes on to recommend increased funding to "provide new vitality for the existing system and a stronger base for the accelerated research we recommend".

We conclude, therefore, that our discussion of incentives and disincentives should deal primarily with improvements in effectiveness of existing USDA and State agricultural research institutions and their programs and requirements for important dimensions of expansion.

We will endeavor to identify and discuss both incentives and disincentives affecting the agricultural research system in practical terms with interpretations drawn from judgements of those who have experienced and studied their impacts.

Appropriate levels and kinds of incentives generally occur if there is recognition of and sensitivity to important realities. We consider the most essential realities to include:

1. The requirement of the agricultural research (innovative) process.

2. The realities of American agriculture in all of its important dimensions and what research can and cannot do to meet its needs.

3. Reasonable balance between expectations for contributions from agricultural research and funding levels needed to meet those expectations.

4. Problems of factoring differing views and expectations (sometimes opposing) of agricultural research.

5. Policies, regulations and organizational arrangements which impinge on agricultural research positively or negatively.

Requirements of the agricultural research process

The common denominator of useful initiatives in agricultural research is the scientists working individually and in groups. They provide the means for expert inquiries into problems and processes in agriculture and for assessing and transforming results of those inquiries into practical and useful applications.

Scientists are reasonably self-motivated. The more capable scientists tend to have an extra measure of self-motivation, and they demonstrate greater research initiative.

Scientists recognize and respond to external influences, more so if they see those influences in a constructive light. Within the limits of their disciplinary expertise and their innovative capabilities, scientists respond to their peers, to their administrators, to their institutions, to funding sources and to the intended beneficiaries of their research.

The more capable scientists are, the more necessary it is to use influences that they see as constructive. The superior scientists have sufficient choices, so they can disregard those influences which they perceive to be unnecessarily coercive or arbitrary.

History has shown that progress in agricultural research has depended very much on attraction and retention of superior scientists through constructive use of incentives to which such scientists would respond. Current and future needs of agriculture for improved technology are greater and more complex than in the past. Therefore, government and institutional leaders who carry responsibilities for the progress of American agriculture, probably will improve the return from their provision and allocation of financial and other resources if the processes used effectively unite the needs of American agriculture with the realities of constructive incentives in research and the elimination or reduction of requirements that result in important negative consequences.

Gustav Ranis recently identified in Science (2) some of the major contributions of Theodore Schultz, cowinner of the 1979 Nobel Memorial Prize for Economics. Ranis wrote, "In education as in research, especially agricultural research, Shultz recognized the importance of public sector actions to improve the environment for individual private actions". Schultz was aware that agricultural researchers will make appropriate rational choices if they have essential information on the needs of agriculture to which each can respond to combine with their scientific capabilities for useful innovations, inventions, or other discoveries. Schultz (3) himself has said "Whereas funds, organization and competent scientists are necessary, they are not sufficient". He proposes the added, necessary dimension of "research entrepreneurship". "Whereas entrepreneurship in business enterprises that are profit-oriented is performed by executive officers, in agricultural research organizations much of the actual entrepreneurship is a function of the assessment by scientists of the scientific frontiers of knowledge. Their professional competence is required to determine the research hypotheses that may be worthwhile pursuing". He warns that research entrepreneurship "is rewarded haphazardly in the not-for-profit research sector; and it is increasingly misused and impaired by the over-organization of our research enterprises. What is happening in agricultural research is on this score no exception".

Edward E. David, Jr., President of the Exxon Research and Engineering Company, and a former Presidential Science Advisor, writing recently in Science (4) pointed out that increased competition, volatility of the market and adversary actions of government have increased pressures for corporate survival. He states "it is not surprising that industrial research is aimed at those fields which are thought to underlie the business of the firm". He goes on to state "both researcher and management assess the potential impact of the result along business and technological as well as scientific lines". Retrospective assessment is quite common for fundamental research, since it is well accepted that its most significant results are not likely to be predictable. In such an environment, quality is essential, and much care is taken in hiring and evaluating research people and providing for their continuing education and training. Applied research may be judged prospectively.

The question may be raised how management maintains an "integrity of purpose" in the research process. David explains, "individual researchers have great freedom, but that the integrity of purpose is sustained by a subtle climate generated by the researchers themselves and their surroundings. One cannot go to work every day for, say, 10 years at Bell Laboratories without absorbing the culture of the communication business as practiced by AT&T. The same is true for other firms. Yet researchers have been able to maintain the creativity that gives rise to unfettered ideas which can revolutionize the company's business". He concludes, "it is management's responsibility to see that promising long-range research is allowed, particularly among the most imaginative and creative researchers, and to encourage an awareness of the larger business environment".

David's summation for industrial research is equally applicable to agricultural research. "Perhaps the critical element is the involvement of working scientists and engineers themselves. It is they who can best evaluate technical feasibility of a projected development".

Agricultural research leaders have recognized the imperative requirement that those who can determine technical and scientific feasibility should be party to addressing the needs. This concept includes involvement of scientists in evaluating progress to meet needs, to identify shortfalls, and to develop new research strategies that are apt to lead to further progress. The role of research administrators has been to encourage sensitivity and responsiveness of scientists to the needs of agriculture, and to see that their proposals are potentially productive through effective combinations of research feasibility and agricultural need. With the assistance of extension specialists and administrators, he can determine degrees and kinds of satisfaction and dissatisfaction among the users. The feedback from the users to the scientists and to their administrators constitute a necessary and compelling force to maintain the "integrity of purpose" for agriculture that David cites as a required principle of industrial research. As in industrial research the "integrity of purpose" is buttressed with the required "quality of research" through careful selection of scientists and their further education and training, use of peer influences in formulation of project proposals, effective research processes, publication of results and in the broader aspects of planning and implementing programs of research. Recognition and reward systems for research contributions should include "integrity of purpose" as well as "quality of research".

We may conclude that agricultural research, and thus its management, has a closer resemblance to industrial research than to research to create improved scientific understandings in that integrity of useful purpose has to be blended with quality of research. Comparing agricultural research to the larger industrial research organization provides an additional common denominator in basic research that is mission-oriented but not necessarily mission-directed. It is the kind of organizational encouragement that led to the invention of the transistor in Bell Laboratories and the principle for capture of heterosis in corn at the Connecticut Agricultural Experiment Station. It recognizes in agricultural research, as in communications research, that some of the fundamental principles are more apt to be looked into in laboratories where the scientists combine an appreciation of useful mission and of their disciplines. Advances in understanding of fundamental phenomena in plant pathogens, insects, soils, rumen function in animals, plant physiology and plant genetics have taken place mostly in Land-Grant university departments and government laboratories with agricultural missions. There are notable exceptions, of course. A number of new and significant insights in those fields have come from quality research institutions that are not agricultural research establishments. But it does illustrate that the "need to know" probably is a stronger motivation than the "desire to know".

Even in the most abstract of the sciences, mathematics, the dangers of disregard of the practical is recognized. John von Neumann (5) stated it well when he said "As a mathematical discipline travels far from its empirical source, or still more, if it is a second or third generation only indirectly inspired by ideas coming from 'reality', it is beset with very grave dangers...whenever this stage is reached, the only remedy seems to me to be the rejuvenating return to the source: the reinjection of more or less directly empirical ideas".

A report of a retrospective study of several technological innovations of high social impact conducted by the Battelle Institute under sponsorship of the National Science Foundation (6) summarized potentials of management of innovation quite well. The agricultural innovations included hybrid corn, hybrid grains and the "green revolution". Their report states "MNOR (nonmission-oriented research) is the most difficult to manage, if it can be managed at all. Furthermore, as we have seen, significant NMOR events continue to occur up to the end of the innovative process; hence we are to conclude that innovation cannot be controlled or programmed. Also, the actions of the technical entrepreneur, or the role of such motivational forces as recognition of need and recognition of technical oppportunity, involve inventive or creative activities that do not lend themselves to detailed planning". The study did conclude that management can aid innovative processes by using funding as a reinforcement to the processes (not as a coercive or threatening force) and for the encouragement of interdisciplinary aggregations to enhance the confluence of technology or the connecting of information from several disciplinary or technological directions to suggest a new, promising direction of research.

Dean Gillette, Executive Director, Corporate Studies, Bell Laboratories provides another management caution from the experience of industrial R&D (7). "Discovery cannot be scheduled, the rate of technology advance cannot be measured quantitatively, and although the purpose of research is to create knowledge, a simple count of publications or patents will not disclose their relevance to corporate missions."

The rest of the paper will discuss interactions of government and universities with agricultural research institutions and their administrators and scientists. The purpose of this section is to identify fundamentals of the creative process of agricultural research that must be considered and hopefully enhanced by actions of governments and universities carrying responsibilities for agricultural research.

III. Existing Incentives

A. Influence of agriculture and its constituencies

This background paper views agriculture as including all farmers and ranchers, public institutions and agencies involved in agricultural programs and activities, support industries that develop, distribute and provide dependable supplies of needed farm inputs and machinery, and an appropriate share of readily available infrastructures for local assembly, storage, transport, processing, and marketing of farm products. Agricultural constituencies include all users of research knowledge and technology developed by agricultural scientists and entrepreneurs, and the primary handlers and all users of fresh and processed foods, feeds, and feed stuffs plant and animal fibers, and industrial products derived from ranches and from commercial, small farm, truck farm, and controlled environment agricultural production.

Agriculture and its constituencies as broadly described is an essential influence in stimulating research scientists, management and administration to meet their needs. Since the welfare and growth of agriculture depend in large measure on new knowledge for advancing the efficiency and continuing dependability of the agricultural industry, it is encumbent on these entities to develop and maintain open communication with the agricultural research community. The objectives of such dialogues should be to assess short- and long-term research needs, progress being made in solving high priority researchable problems, opportunities for implementing new, higher priority research with resources becoming available as ongoing investigations approach completion or reach points of questionable returns in terms of further benefit to agriculture and its constituencies. Research scientists, managers, and administrators need and welcome constructive suggestions and warranted criticism from these entities. This kind of involvement shows a level of interest which can inspire and motivate the research community to a greater commitment in serving mankind without fear of eroding the credibility of science or the excitement it provides for further delving into the unknowns.

Agriculture and its constituencies over the years have had a synergistic effect in significantly improving all aspects of the agricultural industry. This has facilitated a measure of growth in agricultural research which gave a steady rise to new knowledge and technology for advancing the efficiency and continuing dependability of U.S. agriculture to levels which significantly exceed other countries of the world. However, because of program austerities and mounting inflation during recent times this country's reserve of knowledge generated from earlier research but not yet implemented is in danger of depletion. An additional complication appears to be a reluctance of total commitment on the part of various public and private institutions to maximize opportunities for unbiased joint planning, funding, implementation and pursuit of research becasue of the competitive desire for individual institutional advancement and perhaps even survival within the limited resources available at this time in our history. This was further aggravated by a concomitant erosion of dedication among agricultural scientists by the mushrooming of government policies to provide more funds for contract and grant research at the expense of ongoing inhouse resources and programs. This is succinctly exemplified by a subcommittee study (8) which stated in part as follows:

> "The call for mobilization of scientific resources not previously involved is quite appropriate in the subcommittee's view provided the scientific resources previously involved are first fully mobilized. The scientists within the USDA-Land-Grant system have not had an opportunity in recent years to adequately demonstrate their capacity, being restricted to lack of support facilities and personnel and bound to the applied tasks for reasons previously outlined. The subcommittee believes these resources should be the first utilized from an efficiency standpoint."

B. Influence of government

Government did not invent institutions to carry on agricultural research. Early scientists who first perceived and demonstrated how science could serve agriculture extended their experience to the formation of organizations to serve the same overall purpose. Those who were most successful stimulated state governments and the federal government to extend their successes to other agricultural locations.

Samuel Johnson participated in agricultural experiments at Yale and in Germany in the 1850's He wrote in 1855 that "especially in Saxony" there are "experimental farms with laboratories in connection....intended to make science practical and practice scientific, and no agency can be desired better adapted for these important purposes". His advocacy of such an approach resulted in the establishment of the Connecticut Agricultural Experiment Station in 1875. By 1887 legislatures in North Carolina, New Jersey, New York, Ohio and Massachusetts provided funds for establishment of "experiment stations" in those states (9).

Though the organic act of 1862 establishing the Department of Agriculture authorized conduct of "practical and scientific experiments", it did not require their being carried out, and it enumerated additional duties of a non-scientific nature. Added legislation of 1862 impacting on agriculture included the Homestead Act to encourage development of new lands and the Land-Grant College Act designed to assure a higher agricultural education base. These several Acts of 1862 were followed by a sequence of Federal and State authorizations and associated appropriations which permitted the beginning of organized agricultural research and its continuing healthy growth and development.

Commissioners of the U.S. Department of Agriculture were not familiar with science. Thus the array of problems they dealt with in early years delayed until the late 1880's the development of a clear departmental research policy which was based on "long continued experiments". In fact the passage of the Hatch Act in 1887 "to establish experiment stations....in the several States" probably would not have taken place if scientists had not first demonstrated that within earlier authorizations they could serve needs of farmers in ways that farmers deemed useful.

The federal and state legislation for agricultural research (Flatt et al.) (10) enacted over a period of about 100 years has effectively withstood the tests of time, mostly because scientists at the research institutions created thereby have contributed importantly and necessarily to improvements in American agriculture. The initiation of research in the U.S. Department of Agriculture in the late 1880's and activities of the early State agricultural experiment stations, including those established as the result of the Hatch Act of 1887, has resulted in a State/Federal pluralistic agricultural research system that combines close familiarity of the State agricultural experiment stations with the numerous variabilities of American production agriculture and its functional extensions toward marketplaces and the consumers with a centrally organized agricultural research system that effectively compliments the state efforts. This system attests to the forthright manner with which Federal and State governments carried out their entrusted responsibilities for providing a healthy atmosphere for scientists to use their inquiring minds to extend the frontiers of science and its agricultural knowledge base. Further, over time, the system resulted in progressive and steady advances in various fields of agricultural technology important to conservation and wise use of land, water, biological and other natural resources, protection of the environment, the health and well-being of people through more efficient agricultural production and industrial development, better balanced human nutrition and greater understanding of the social sciences which undergird the effective functioning and contributions of this country's array of social structures.

In fact the new knowledge which evolved from the time agricultural research began, along with the ingenuity and entrepreneurship that put these findings and associated infrastructures into practice, resulted in the United States accomplishing a level of efficient food production and distribution during the 20th century which far surpasses most countries of the world.

In the Federal government the Congress seems to have been more comfortable with the loosely federated agricultural research system over time than the more recent administrations in the Executive Branch. Perhaps members of the Congress representing individual states in the Senate and districts within States in the House of Representatives could perceive more easily the twin values of encouraging states to sponsor and take responsibilities for agricultural research, while continuing to authorize and support research in a Federal Department of Agriculture. Despite this the Federal appropriations for agricultural R&D has slipped from 40 percent in 1940 to less than 2 percent of the total Federal R&D in 1980. This has been further impacted by an enlarging back-log of new high priority problems needing to be researched, inflation, and federal administrative policies to reduce the number of Federal employees, including scientists. The net result of these disincentives has been less research with an essentially static agricultural research budget for the past 10 years, decreasing numbers of scientists with very few young scientists having been employed and trained to fill ARS research leadership positions vacated through retirements or resignations and a most serious erosion of morale and motivation of scientists.

1. Morale of Scientists

Deterioration of morale of ARS scientists became extremely critical with the drastic reorganization of this agency in 1972.

Prior to the reorganization of 1972, expertise relevant to the disciplines and responsibilities of the scientists extended to the Division level. Animal scientists reported through successive levels of administrators to a Division director, all of whom were animal scientists knowledgeable of the needs and nature of animal agriculture. The same was true in the other Divisions. Thus, at all these levels of administration there was a leadership capacity to merge and meld political and administrative preferences from above with promising program improvement proposals arising from the expertise of knowledgeable scientists. With the abolishment of all Research Divisions and Branches plus several hundred National Research Investigation Leader positions and the restructuring of ARS activities within regions, the 3000 plus ARS scientists, had difficulty determining how their future research would relate and contribute to continuing national research missions. Several years later as the ARS 67 National Research Programs, which transcend regional boundaries, were implemented under the coordination of ARS National Program Staff scientists, the morale of many scientists began to improve. However, before the agency scientists made the adjustment another major reorganization was implemented which combined four former agencies (ARS, CSRS, Extension, and the National Agricultural Library) into the Science and Education Administration. This resulted in a drastic setback in morale of SEA/AR scientists and a slippage in morale of the state scientists. The status of the four agencies was restored in 1981.

There were important differences between the reorganization of ARS in 1972 and the reorganization which created SEA in 1977 as they impacted on employee morale.

T.W. Edminster, Administrator of ARS, and his associates in 1972 carefully refrained from rearranging scientists or their duties as a direct part of reorganization. This was done so as not to compound their negative reactions to the change in leadership patterns deemed necessary to more effectively relate ARS activities to those of the States as they both served American agriculture in their unique but coordinated ways. Other changes were also made to try and reinstate valuable processes, though in different form. The important point is that the reorganization was not formed, activated and finalized until internal functional considerations were weighed as thoroughly as were external preferences. In fact, if there was an imbalance, it would seem to be that important members of the Congress did not feel they were consulted sufficiently.

The formation of SEA, on the other hand, was triggered by a decision to consolidate a number of agencies, particularly smaller ones, throughout government. The result was a lumping of the agencies that comprised the "Science and Education" component of the Assistant Secretary for Conservation, Research and Education with some additional organizational modifications within the larger grouping. The first permanent Director came on board after virtually all of the organizational decisions had been made.

The major problems appeared to lie in constraints of context and attitudes.

The problems of context required the new Director, though respected and capable, to transform a new organization chart into a functional institution while budgets were tightening and personnel ceilings were being lowered. SEA-AR with most of SEA's money and personnel had simultaneously to bear its own burden of attrition and sacrifice part of its resources to fund and populate new units. Scientists in SEA-AR saw and were affected by the reduction, but generally did not see compensatory good.

Perceived negative attitudes of the Administration tended to encourage negative responses to the changes. Scientists, who may have earned the plaudits of agricultural leaders and the respect of their peers, found themselves grouped with all other "unresponsive bureaucrats". The greater use of the adversary approach to improve government processes tended to be translated at the scientific levels into increased time requred for justification for budgetary and other reasons and resulted in a growing impression that agricultural scientists should be directed more and trusted less.

The result has made it difficult for SEA/AR to compete with non-federal employing agencies and institutions in attracting and holding promising young scientists. Moreover, many of the better long-time-service career scientists of SEA/AR show evidence of losing the dedication, drive, and innovation exhibited in earlier years.

In our judgement the best approach to overcoming some of the mushrooming and ever-worsening scientist morale problems is for the federal government to settle down into a long-term smooth-working organizational structure which fully supports a strong federated research system in which the scientists are appreciated and they can participate in priority settings and program changes.

2. Federated Research System

Apparently the U.S. Congress has long sensed that genuine benefits would accrue to the nation's agriculture by urging that the state agricultural experiment stations and the federal inhouse research agencies coordinate their research efforts without requiring that one group dominate the other. Further, over the years, it is recognized that state and local perceptions of priority needs and the research feasibilities required to meet those needs, particularly in production agriculture, should be harmonized with national perceptions. The record shows that the Congress, through formal legislative reaffirmations and through appropriation processes, continues to support research at the State agricultural experiment stations and in the Department of Agriculture. Primary annual budgetary add-ons usually are earmarked for specific or new programs which often are only partly related to the State agricultural experiment station programs. Some of these include the McIntire-Stennis Cooperative Forestry Research Act, establishment of support for research at 16 predominately black colleges which have had Land-Grant status since 1890 and Tuskegee Institute and the introduction of a competitive grants program in basic research. In recent years a formula funded program was authorized for research in animal health, but funding has been limited and discontinuous.

The McIntire-Stennis Act has expanded the contributions of State stations in forestry, but the Act encompassed additional institutions, publicly supported forestry schools and forestry units in parent universities of State stations but administratively separate from them.

Agricultural research support at the 1890 Colleges and Tuskegee Institute remains federal almost entirely. However, coordination among the research programs of these institutions and between them and the State agricultural experiment stations has been increasing.

The USDA competitive grants program in basic research was intended to attract superior scientists wherever they were located to do research on fundamental processes of plants and human nutrition. About half of the awards have gone to scientists in the State agricultural experiment stations.

At the present time the two levels of government, federal and state, have reached approximately equal significance in support for agricultural research. About 60 percent of the publicly supported agricultural research in the United States is under the direction of state officials, mostly directors of State agricultural experiment stations. About 17 percent of the support for those institutions is of federal origin through the Hatch Act. Thus the financial division between state and federal is more evenly balanced on a national basis.

A loosely knit but functional harmony continues to exist among the State stations and between them and the research agencies of the Department of Agriculture, especially with the Agricultural Research Service and with the research unit in the Forest Service. Common denominators of purpose related to needs of agriculture and forestry have caused the State and USDA units to work together in a number of ways and places. Conversely, in recent years, very few institutional interactions have taken place between the Economics, Statistics and Cooperative Service and the State agricultural experiment stations, seemingly associated with ESCS preoccupation with national and international issues and increased use of scientists in that agency by the Secretary for policy development.

The State agricultural experiment stations vary in their susceptibility to Federal influence. In the larger agricultural states, with a strong tax base, the State stations utilize a sizeable financial support from the State to serve the needs of a large agriculture. Hatch support in these is below the national average of 17-18 percent. The smaller agricultural states, especially those with lower tax incomes, are more dependent on Hatch funds. History has shown that Directors of the larger state experiment stations will respond to national research priorities if they can be party to their formation. Further, they will participate in regional and national planning processes jointly carried out with USDA leaders if the federal appropriation process reasonably rewards the outcomes of the joint planning. The weakness of coercive or adversary approaches in federal budget development or in federal legislation is that the State station directors in the more important agricultural states are less apt to respond to them, if they exceed or are inconsistent with state priorities.

There are a number of other actions, policies and procedures which have shown a positive "net worth" to the agricultural research system which cannot be treated fully in this paper. They include the establishment of regional research programs under the Hatch Act, activation of joint USDA-State research planning, development of research network arrangements that join new ARS programs with similar programs in the State stations on a continuing basis, and a number of interactions between individuals, scientists and organizational units of the research agencies of the Department and their state counterparts that have served needs of American agriculture and forestry in ways that are superior and more significant than if those activities had been carried out by either side independently.

The rest of this section will deal with trends, policies and actions that were logical for their own central purposes but when applied too rigidly or narrowly have tended to divert from rather than augment the stated purposes of laws that authorize and encourage agricultural research and the programs carried out under them. They will include some actions of the Congress, generally made for other purposes, which impinge on policies and procedures for agricultural research in diversionary ways.

3. Labeling Hatch funds as formula grant funds rather than as USDA-State "partnership" funds.

The catalog of Federal Domestic Assistance lists Hatch funds and funds authorized by Acts patterned after the Hatch Act as formula grant funds. This has caused Hatch and comparable funds to be subject to the myriad of rules and regulations that the Office of Management and Budget has developed for grant and contract programs. On the surface, that would not seem inappropriate. However, "simplification" of procedures has resulted in expanding a procedural manual for the Hatch Act that reached 12 pages in 90 years to over twice that many pages in its replacement, (not released at this writing) not including a thick compilation of "applicable" OMB circulars that make up the appendix. OMB officials have made it clear that no deviations will be permitted for program reasons. Neither State station directors, nor officials of the USDA, including the Office of the Secretary, are permitted to deviate from the procedures unless permission in writing is received from OMB.

OMB has granted exception from the imposition of full negotiated overhead rates on the Hatch Act, the McIntire-Stennis Act and 1890 College research funds authorized under Section 1445, P.L. 95-113. Events showed that strong advice from key budget officers from Land-Grant Universities who understood the values of maintaining the USDA-State research partnership principle was needed to get the exception. The Secretary of Agriculture did request the exception, but it seems unlikely that his request would have been sufficient without the support of the knowledgeable State university budget officers.

The concern of the program people, USDA and State, is that continuance of the formula-grant label and its "Big Daddy" and "soft money" connotations and consequences may ultimately encourage the parent universities of the research performing institutions to treat the funds similarly, especially if total funds for those universities become more limited. In such an event, the categorical assignment to "formula grants" would become self-fulfilling in function regardless of the program intents the Congress may write into those Acts unless other clarification is provided.

4. Research as a budget cost rather than public investment

Recent analyses, using procedures deemed satisfactory in advance by Federal budget officials, have shown that prospective returns on additional investments in agricultural research at the State agricultural experiment stations would return as much net profit in the form of public good as has been realized in past years. Returns of 30-50% annually would be realized in net value over investment costs and a 10% annual discount rate. Similar analyses on added investments in production research to be conducted by ARS would likely show comparable results. Private business firms usually are willing to invest if the expected net return is 15% annually over an appropriate discount rate.

Though the results of these prospective analyses and a number of retrospective analyses show that much of agricultural research can and should be judged on the basis of public investment, and the resultant resources managed accordingly. The complications and rigidities of the Federal budget process have effectively prevented consideration of agricultural research in that vein. However, notable improvements have been made within the USDA in this regard.

A caution should be made here. Investments in research can be analyzed and assessed after their completion. The more uncertain and high-risk research, such as much of the basic research, or developmental research directed toward new and untried technologies, should not be analyzed or directed in excessive detail too early in the process. Large industrial R&D laboratories, for that reason, manage for research, even at applied levels.

There is a recent example of Federal consideration of agricultural research as a public investment. Robert W. Long became Assistant Secretary for Conservation, Research and Education in 1973. His experience included investment processes (Vice President for Agricultural Affairs for the Bank of America), management of a large agricultural production operation, and knowledge of agricultural research through his formal advisory services to the California Agricultural Experiment Station. During his USDA tenure he launched the new competitive grants program in the USDA for basic research and succeeded in getting a $15 million appropriation for it the first year, while justifying significant program increases for research at the State stations and in the Agricultural Research Service. Though he did not dictate terms for the use of base program increases, he did insist on evidence of good management of total research resources of which the increases were to be a part.

5. National versus state priorities

Federal funds should be related to national purposes. The problem of the application of this principle to agricultural research is mostly the difficulty of applying it to the diverse components of American agriculture.

National priorities become categorical. Major commodities and the larger problem areas can be considered together and in budget or program competition with each other quite well.

Priorities developed within each state tend to be quite specific.

The problem lies in the nature of American agriculture itself. Almost all of it is both subnational and supra-state. Even though production agriculture is very environmentally dependent, the value of very little State-sponsored research is limited to the political boundaries of the state which is funding it. Recent analysts of agricultural research call this a "spillover" effect. From the standpoint of the public, the spillover effect is good. The benefits of the research done in one state extend to other states. However, the director of a State station cannot use benefits accruing to neighboring states to justify additional funds from his state legislature.

Conversely, most of the spillover value is limited to relatively few states, often neighboring ones. Unless the potential value benefits a great many states, it becomes difficult to develop much federal interest in its support. Cureent exceptions include the federal research on certain minor crops such as filberts, guar, sesame and lentils which came about because of Congresssional action in response to constituent pressures from localities where such crops are grown.

Therefore, the more strictly that federal and state governments insist that potential benefits must be proportioned to their respective political jurisdictions, the larger will be the proportion of agricultural research that slides to lower priority levels. Some research that may benefit several states, but that is not a top priority item in one of those states, may be neglected entirely.

Another complication is one of proportionality. Development of a priority setting process that gives proportional consideration to intense problems of more limited coverage is feasible where knowledgeable scientists are involved. However, those items tend to disappear entirely in the "big bucks" stages in the development of the federal budget.

6. Basic, applied and developmental research

If all of the problems could be solved and the advances made in agriculture through applied research, then, in interest of saving tax dollars, no basic or developmental research should be funded. Applied research is the shortest operational distance between the laboratory and the field or farm yard.

However, as new advances become more difficult to achieve, as the public wants more attention given to side effects, and as American agriculture becomes more complex, scientists are having to examine more thoroughly processes and phenomena fundamental to American agriculture in its broad sense. This has resulted in over a third of the research at the State stations and over 40 percent of the research in ARS becoming basic in nature and a growing proportion of the remaining resources being diverted to "defensive" research.

One of the problems has been one of perception. In the context of agricultural research, basic research is an extension into the unknown from applied research. Thus, it is a part of the functional continuum of basic, applied and developmental research. However, the predomiant federal perception holds that basic research is inherently valuable if not necessary to our progress, but is limited to that research whose ultimate practical value cannot be determined, except in general terms. Thus, the competitive grants program in basic research is seen as a means of improving general knowledge not directly connected with the applied needs area.

Most basic research in agriculture is related to mission. If not directly mission supportive or directed, it is mission-oriented. Relatively little is classically basic. Agricultural research is much like industrial research. As Edward David points out "The goal orientation or purposefulness of industrial research almost rules out basic research according to the motivational definition adopted by NSF".

Developmental research or the coupling of research and development in agriculture has taken a different course than in industry or in some other federal agencies such as defense. Most of the technological advances from agricultural research have been rather directly insertable into the farm or agricultural business enterprises. Developmental research such as crop breeding, improved mechanical aids, insect control methods etc., was carried out as a means of final transfer of improved technology to the farmers. As private industry found some of them profitable, the public research institutions tended to pull back from such developmental research, while, at the same time, the private companies continued with further developmental improvements.

A partial vacuum has occurred in those areas where private industry does not see rather immediate profit. This has caused federal research funding organizations other than USDA to support developmental research that may lead to major technological replacements rather than smaller modifications. Thus, the research on leaf proteins for protein feed supplements for swine and poultry and for refined protein additives to human foods has been funded more substantially by the former RANN program of NSF than by the USDA.

The major exception has been a program of leaf protein refinement at the Western utilization laboratory of ARS. If leaf proteins are to become of major significance, feasibilites for a major new system of production, processing and storage probably will have to be developed. The high risk and cost of such research usually exceeds what private industry perceives as a reasonable and safe business investment.

7. Agricultural research and private industry

The primary difficulty from the standpoint of government seems to be in defining in simple categorical terms the rather complicated functional interfaces between publicly supported agricultural scientists and their private industry counterparts. This results in such public "don'ts" as "if industry can or should do it, then public funds should not be used" or "if publicly funded research results in profits for private industry, it should be stopped". Neither statement, in principle, is incorrect. However, their applications at the margins become uncertain, because the interface between the public obligation and the private entrepreneurial interest is not sharp and distinct, and industry is often not willing or interested to provide necessary information to determine their common boundaries of responsibility.

Increased effects of government regulations, the absorption of former agri-industries into multi-interest conglomerates and the increased integration of agriculture into the total fabric of development has made it more difficult to address the public-private agricultural interface as a separable and definable issue.

Social and environmental consequences of agricultural development, though important to consider, add complicating dimensions to the issue. This is particularly true if some of the economic benefits from a new or improved technology accrue to private industry, and some of the social and environmental effects are considered negative.

The separateness of the component parts of American industry serving agriculture makes it more difficult to appropriately describe the interfaces between publicly supported agricultural research and industrial R&D. If one segment of industry, such as farm machinery, does not interact with another segment in meaningful ways such as vegetable oil processing, then those in the public research sector must deal with each separately. R&D opportunities or action needs require specific and thus knowledgeable consideration whether in the public domain, in the private sector or in a zone of interaction. Broad government policies and actions which affect different industries similarly can be considered through representatives of diverse industry groups. New technologies require much more specificity than that.

Another way of assessing the relationships between public and private R&D in agriculture is to determine if there are gaps between "product or service-oriented" or "developmental" research in the private sector and public needs. Where they may be found and determined to be important, then private and public R&D leaders can jointly determine how the gap might best be corrected.

8. Complementarity of base funding and selective funding

History has proved that base funding has been more versatile in adaptation to the complex needs of agriculture and more sensitive to change than selective funding. The closer a scientist has been to the users of his research outputs the more the scientist adapts his research to the needs of those users. The influence of the user is manifested in two ways. Scientists are hired whose skills and interests match the area of need. Once hired the scientists must show progress in meeting important needs or the users will find ways to apply pressures to the research units until the need is met or they are satisfied that what can be done is being done.

Sensitivity to change may be illustrated in the area of environmental quality. Between 1970 and 1974 the State agricultural experiment stations more than doubled the scientist-years devoted to that problem area, mostly by redirecting existing resources. By the time agricultural aspects of environmental quality had become serious and widespread enough to warrant national attention, a number of scientists, state and USDA, had addressed their scientific talents to important facets of the overall problem.

The purpose of this section is not to downgrade the place and value of grants, cooperative agreements and contracts to stimulate research in specified areas or for special purposes. The purpose is to show that they can be useful compliments to base program activities if used to augment and accelerate interests already in place and efforts already started rather than at the expense of ongoing activities.

Problems, in fact, have occurred when federal authorities proposed that grant funding be provided by cutting base funding. The President's budget proposed in FY 1979 a further increase of $15 million for competitive grants for basic research combined with a $9.4 million decrease in Hatch appropriation with the words, "A reduction in Hatch Act payments is requested in 1979 as a part of reorientation of research priorities toward competitive grants". The Congress rejected both proposals, but some political damage was done. In the previous year, the State agricultural experiment station directors had supported the initiation of the new grants program, because modest increases in base program support, balanced between Hatch and ARS, had been recommended at the same time. The requests were sustained by the Congress. In 1979 the State station directors were very reluctant to support the proposed increase for competitive grants for fear that such support would be considered tacit admission that part or all of such increases could be snipped from the Hatch appropriation.

If all of the states had the same profile of agriculture and comparable levels of production, it would be easy to reflect changes in research needs and opportunities on a basis of national concensus. However, the dynamics of need and opportunity occur at levels of detail or in geographic localities (which usually do not coincide with the political boundaries of states) and are sufficiently diverse in their characteristics that they are difficult to aggregate into categories which are meaningful as 'national' priorities. However, the more that base programs become preoccupied with meeting those many diverse needs, the more they have been seen as insensitive to 'national' priorities.

9. Mutual exclusiveness of USDA and State Research

There have been periods, as in recent years, when policies have favored separation of USDA and State research in agriculture. Interestingly, some policies in the USDA have been in the opposite direction.

Increasing pressures on the federal budget have required federal agencies to look inward to justify and protect programs they felt were important. Using federal dollars only to further federal purposes was a natural outcome of tight budgets.

During such a period, however, the Forest Service has gone to great lengths to plan research jointly with the State agricultural experiment stations and cooperating forestry schools, and they have overtly encouraged increased funding for research at those institutions through the McIntire-Stennis Act.

Over the years ARS, under its succession of agency names, has invested heavily in a number of partnership ventures with the State agricultural experiment stations. One example out of many is the wheat improvement program at the Indiana station. Around 1950 the Director of the Indiana station encouraged the hiring of several young scientists of superior promise to team up with several state scientists of proven capabilities. The Agricultural Research Service provided the entomological expertise. The results? By 1980 over 80 percent of the soft red winter wheat in the eastern corn belt and contiguous areas was planted to varieties released from the Indiana program. The modest ARS investment provided the necessary additional encouragement to cause an in-state research program to provide multi-state benefits in full measure.

The conflict seems mostly to be between program judgement, which in research is generally long-range, and budget judgement which is exercised on an annual basis.

In a real sense budget judgement takes precedence. ARS has lost a significant amount of its program flexibility through combinations of sustained personnel reductions, earmarks for which funds were only partially provided or not at all, demands for service from action and regulatory agencies, loss of ability to negotiate less than full overhead rates in research done by non-federal cooperators, and political constraints against closing out less productive locations and programs.

The State stations have not been able to cushion the shocks of change in ARS generally because of the precipitous ways that higher administration mandates that such changes had to be made and announced. Short notices not only prevented the State cooperators from developing and carrying out compensatory actions, but, if an ARS withdrawal put a program important to the state in jeopardy, the State cooperator had no alternative other than to publicly oppose it.

10. Influence of the Office of Technology Policy

This section is included primarily for positive reasons. Most of the major corrections and improvements made in research policies and arrangements in the USDA in the last few years were suggested by or were consistent with advice from OSTP. These changes included elevation of the Director of Science and Education to the Secretarial policy level. OSTP recognized that a person knowledgeable of the realities of research and education processes was needed to interact at that level in the Department.

The OSTP experience suggests that an understanding of science (OSTP officials had not been recruited from agricultural research prior to the actions described here) coupled with a study of the agricultural research situation is superior to competence and experience in agricultural action and regulatory programs when faced with developing sound and useful agricultural research policies. It should be recognized that Secretary Bob Bergland reacted positively and promptly to the OSTP suggestions.

The agricultural research community has not agreed with all of the conclusions and perceptions of OSTP, but most agricultural research leaders support its continuance and encourage its Director to select one of his assistant directors from agricultural research as the leading longterm example of research dedicated to public purposes.

11. Status of research in USDA at the Secretarial level

The issue here seems to be two-dimensional. On the one hand, the proportion of the USDA budget that supports agricultural research may not seem high enough to justify an Assistant Secretary for that purpose or one selected with experience in or with agricultural research. On the other hand, since further advances in agriculture and forestry will depend mostly on improved technologies, then research to create such technologies would seem to be of Secretarial importance. The latter reason appears to be the motivation for most recent recommendations for an Assistant Secretary for research and education, including the National Academy of Science report on Food and Nutrition (1).

The predominant assumption in the top echelons of the federal government in reacting to the proposal for an Assistant Secretary for Science and Education appears to be that research and education leaders are seeking more power. Though research leaders value closer access to the levers of power, they mainly seek leadership at that level that understands the research process and how it serves American agriculture.

The situation where Anson Bertrand has been a member of the Secretary's circle is very satisfactory. He, like Edward David, President of the Exxon Research and Engineering Company, and William Baker, recent President and Chairman of the Board of Bell Laboratories has been a superior scientist, understands how science can serve the purposes of his organization and is respected as a research administrator. All three brought superior knowledge, insights and expertise to their positions. They were trusted by scientists and other members of their organizations to represent the substance, purposes and promise of the research programs to others in a realistic fashion, while maintaining necessary allegiance to higher authorities.

In the past, whether it be a Commissioner for Agriculture in the 1800's or an Assistant Secretary for Conservation, Research and Education in the 1900's who is expert in conservation but not in research, there is apt to be important deficiencies in understanding of research or interest in it - or both. History has shown that pressures and petitioning from below can only partly compensate for limited understanding and interest at the Secretarial level.

One can rightly say that people appointed to Assistant Secretary positions are capable of learning what they need to know. They are - but not enough in the period of less than two years that has been the average tenure of Assistant Secretaries throughout government in the last few decades - a period less than half the time needed to complete the average agricultural research project.

12. Support for action and regulatory agencies

So long as research is concentrated in agencies for that purpose, and action and regulatory agencies are denied a research arm, then the USDA research agencies are obligated to conduct research which meets the most urgent program needs of the other agencies in the Department. ARS has a long and useful record of service of that sort within USDA.

There seems to be two kinds of problems. One, the public purposes which an action agency and the research and education agency can address together is often relegated to a status lower than policy and action decisions made by the action agency for which that agency wants research backup. It is the difference between researching a loan to build a rural airport, and a study of best means of providing air services in a rural area coupled with financing for a superior plan.

Regulatory agencies add another difficult dimension. They are required to carry out laws to preserve human safety, environmental conditions, etc. The laws are often quite mandatory and specific, leaving little room for judgement, even after considerable research information is obtained. In fact many times the laws and regulations are so inflexible as to preclude making changes for betterment even though new scientific knowledge clearly justifies it. The primary difficulty is how to do research that helps to strike the best balance between allaying human fears and public concerns while enhancing progress important to those same people. There is also a political problem of balance between the emotions connected with human fears and the lesser interest most people have in reaching the more distant horizons of progress which agricultural scientists strive to reach.

C. Influence of parent universities.

The Congress recognized the mutual values of combining agricultural research with agricultural teaching by urging that State agricultural experiment stations, authorized to become established by Hatch Act of 1887, be located at the Land-Grant colleges authorized by the Act of 1862. Particularly, the training of graduate students in agriculture and forestry was enriched by permitting them the opportunity of learning research by doing it themselves under the guidance of experienced scientist-professors. Research processes were enhanced by the participation of bright young people seeking advanced degrees.

However, the Congress made it clear that the purpose of the agricultural experiment station was to meet the needs of the agriculture of the state through research. It was not just an authorization to do research of an agricultural nature. The judgement was to be made on the usefulness of the results and the problems solved more than on the quality of the scientific processes even though the two dimensions are positively correlated.

State station directors continue to honor the prime responsibility to the state's agriculture and rural life. As the parent universities have grown in size and complexity, the station has been helped in some ways. In other ways, the opposite is true.

1. Resources of the parent university

Many of the expanding resources of the parent university are valuable to and are utilized by the agricultural experiment station. The Land-Grant university libraries, aided by their direct hookup with the National Agricultural Library of the USDA, provide ready access to published information in agricultural research and related sciences. Computing centers, special research equipment and facilities, and advisory and collaborative expertise in the sciences basic to agriculture, plus the physical and scientific resources of the station itself, add up to a substantial capability to serve a state's agriculture through research.

Particularly, as the need grows to inquire more deeply and completely into processes fundamental to further advances in agriculture, the improving resources of the parent universities as well as of the State stations themselves offer special promise for meeting those needs.

2. Responsibility of the station to the State and to its parent university

Though the State agricultural experiment station has remained as a valued and important organization in its parent Land-Grant university, the growth in size, diversity and complexity of the university has created some problems.

With an increase in size of the University the purpose of service to the State becomes confounded with the purposes of the University that are intended for the benefit of the State but are quite different in nature from a service of primary concern to agriculture.

Like all great Universities, those with Land-Grant status are using research to create new knowledge for its own sake, to attract funds from federal granting agencies and to stimulate scholastic excellence. The larger the university (often a system of campuses) and the higher the proportion of interest of its citizens in non-agricultural matters, the more difficult it becomes for the Director of the agricultural experiment station to maintain the integrity of purpose to service the agriculture of his state through research.

The problem is greatest with grants and cooperative agreements. Under provisions of P.L. 95-224 and OMB interpretations of it, all grants and cooperative agreements, whether they are intended as federal - state partnership agreements for the mutual interest of both, or if they are only to carry out federal purposes, are interpreted in the spirit of federal purpose. One result has been that the need of the parent university for money has surmounted even existing agreements of cost sharing. Though federal rules only allow and do not require provision of full negotiated overhead rates, the program agency head is effectively powerless to deny requests of the parent university for the full amount.

A fundamental question seems to be whether certain kinds of agricultural research activities and arrangements truly conform to USDA-State partnership principles functionally and financially and can be so defined. If they can and should, then accountability procedures and financial arrangements should be consistent with the partnership principle inherent in the program authorization.

3. The University reward systems

The Land-Grant universities like other universities have based their reward system on the significance of a professor's contributions of new knowledge and evidence of scholastic achievement. Since both are manifestations of effective research, they are not inconsistent with the reward needs for faculty who are members of an agricultural experiment station. In fact, agricultural scientists producing the most primary journal articles also tend to create the more significant new and improved technologies.

However, there often exists some research distance between a new principle and its applications. The scientist studying the fundamental processes within the rumen of a forage consuming animal may be able to publish four to six times the number of scientific articles over a period of time that his counterpart can who is trying to translate those findings into useful changes in the feed bunks of beef animals. Though some universities are seeking ways to recognize the necessity of the more practical research to achieve farm or other applicatiions, more still needs to be done to reward and thus attract capable scientists to address applied problems that may be locally imperative but which yield fewer refereed journal articles.

4. USDA - State partnership

Much of the landmark agricultural legislation is premised on the true spirit of cooperation between the Federal and State governments. Among the earliest of such actions was the Hatch Act of 1887 which provided for Federal assistance for establishing State experiment stations to tie in with the U.S. Department of Agriculture. This principle was amplified in the early part of the 20th century concurrent with many legislative actions including authorizations which established a number of subject-matter research bureaus in the U.S. Department of Agriculture. The underlying inhouse research philosophies of the bureaus implied and oft times specified that research missions be addressed by locating scientists in areas and regions where the problems to be researched were of paramount importance. There evolved a genuine desire and need for certain Federal Research Bureaus and corresponding departments of the State agricultural experiment stations of Land-Grant universities to collaborate in planning and implementing truly cooperative research programs through wise use of resources within appropriate Federal and State laws and regulations. Records show more than 75 years of such cooperation with the result that all the organizational entities benefited immensely from this working relationship. The true partnerships which evolved in such arrangements have shown that the USDA and State(s) provide manpower and other support either in actual dollars or in kind.

One common kind of partnership arrangement has been for the State to provide a long-term low-cost lease for land, usually on campus of the Land-Grant university, on which Federal greenhouses and/or research laboratories were to be constructed. Generally the State further assures continuing support in kind through providing land for field research plots and/or assigning State salaried technicians to work for and under the technical supervision of Federal scientists at the locations. Another common arrangement was and continued for the State to provide the office, laboratory, greenhouse, and field space needed by Federal scientists engaged in full-time research at the State locations in question. The cooperative research pursued in such ventures free the States of the need to employ full complements of State scientists to conduct similar or complementary research on the same commodity, problem, or mission. More than 1/3 of the current 2700 ARS scientists working at more than 150 research locations are housed, and conduct their research, in such State facilities through a cooperative agreement which generally precludes AR having to pay any overhead costs to the State. In fact this type of cooperation has been so commonplace that historically AR budget requests have not had to include funds for overhead costs to the cooperating State(s). Further, funds for new federal facilities and the research programs subsequently to be pursued therein are appropriated with Congressional understanding that the contemplated cooperative research program will be a truly Federal/State partnership which generally precludes the involved Federal agency from paying overhead costs (except for utilities) to the State.

The above described cooperative relationship appears to be in serious jeopardy following recent passage of P.L. 95-224. This law puts cooperative agreements, the legal document for cooperative research, in the same category as Federal contracts and grants both of which permit full negotiated overhead costs. This new legislation is being viewed by top administration of a few Land-Grant universities as an opportunity for generating more funds for the University without due regard to commensurate reductions and delays in programs and the difficulties in explaining that logic to the Congress. Should full advantage of the legislation be taken by all Land-Grant universities, there would be an erosion of upwards of 40 percent of funds heretofore going into programs covered by such cooperative agreements. More objectively, it means that these funds for cooperative agreement research would provide only 60 percent as much actual support of the research as experienced heretofore. This change in policy would substantially reduce an important incentive to continue the kind of cooperative Federal/State research partnership on which much of the agricultural scientific knowledge base in the United

States has evolved. Further it would betray the credibility and confidence agricultural administrators have repeatedly reaffirmed with Congress over the years in assuring that cooperative agreements are an efficient and cost-effective mechanism for planning and carrying out agricultural research.

A true partnership must be examined from both ends of it. Even though this topic was discussed early in this paper from the USDA standpoint, it must be also considered from the viewpoint of the States.

a. The states are capable of interacting with USDA counterparts in many ways at scientific and administrative levels to meet the needs of American agriculture. They are willing to operate under guidelines that suggest what is appropriate for each of the partners to do. They are not willing to operate from behind barriers, federally constructed and defined ("the states should only do research on local and state problems").

b. The state research partners are willing to interact total segments of research programs with USDA counterpart efforts, not just those portions federally funded, provided the interaction is reciprocated by the USDA.

c. The state partners are willing to include all of their research programs in joint planning and coordination efforts with USDA counterparts providing
   1) the involvement of USDA counterpart is as high as their own,
   2) program decisions in USDA are sensitive to joint planning outcomes,
   3) the federal budget is sensitive in a meaningful way to results of joint research planning,
   4) the differences among states and regions with respect to their agriculture and the institutions serving their agriculture are recognized by the USDA and other entities of the federal government (as this point is recognized in the Hatch Act), and
   5) the joint planning and coordination activities enable the state research cooperators to serve their respective states in ways that state government leaders and users of the research recognize as valuable.

The federal government has improved its sensitivity to effects of its various actions on the environment, economic and social well being of various groups, and on utilization of various resources. If the USDA and the States can better serve the needs of agriculture and forestry and rural life by including the needs of the consumers of food and fiber products through better collaborative efforts in a partnership mode, then it would seem appropriate, in the public interest, to examine those federal laws, procedures and policies which affect the operational effectiveness of the partnership. Just as in the case of other important public side effects, if the federal action is helpful, fine; if neutral, ignore; if there are negative effects of some magnitude, some change should be made to reduce or eliminate the effect.

D. Influence of professional societies and the scientific community

Professional societies have been most effective for many years in providing an organizational interface among member scientists whose primary interests are to report among scientist's peers on progress of research underway and to survey the so-called state-of-the art. These opportunities are provided through paper-giving sessions before forums of scientists brought together from Federal agencies, universities, and the private sector during annual and special meetings planned under the auspices of one or more professional societies. This continues as an effective means for individual scientists to keep abreast of research in progress but not yet published, and for upgrading scientific initiatives. An additional and highly significant opportunity afforded for scientists is to publish scientific papers in the scientific journal of the professional society in question. Other opportunities for professional societies to stimulate a more vibrant motivation of scientists is elucidated in another section of this background paper.

There are many long-standing (some dating back to the 1930's) mutual interest crop commodity, animal breed, natural resources and specific pest control conferences, each open to the entire community of public and private agency scientist. None of the conferences are dominated by any professional society or research institution. These mutual interest groups hold periodic meetings for the scientists to contribute to and participate in the specific agenda planned for the meeting in question. These conferences provide excellent opportunities for scientists to keep abreast of the cutting edges of the ongoing research, on the problems that most deserve their research attention, and to "recharge their scientific minds" so-to-speak.

Trade associations, although primarily market oriented, frequently sponsor conferences on scientific issues which undergird the commodities of prime interest to the association. Outstanding speakers from among the entire national and international arena of scientists are invited to present plenary and general session papers, thereby inciting trade people to react as a constituency sounding board to the research thinking of the time. This interface and exchange helps to build and strengthen an atmosphere of continuing communication between such divergent groups all of which have vital interests in and a responsibility to the agricultural industry specifically and to society in general.

IV. Improvement of Incentives and other Stimulative Forces

A. Requirements of the Research Process

The recommendations in this section include those intended for action and some intended for consideration. Some contain elements of both.

The reason for both kinds of recommendations is that incentives and disincentives in agricultural research result as often from actions taken for purposes other than research but which impinge upon it as on actions directed at agricultural research. In some cases, it may not be appropriate to exempt agricultural research, or parts of it, from a policy or action that is adverse to it, as in budget reductions. However, in the national interest, it is as important to assess the effects of government and university actions on research as it is to determine their effects on other important dimensions such as on the environment. Since agricultural research organizations and their primary processes are long-term, then long-term effects of external actions should be included in the appraisals.

Recommendations:

1. Attract, retain and encourage scientists with superior capabilities.

This recommendation refers to the most essential virtue of a research organization. If agricultural research organizations, USDA or State, have carried out this recommendation successfully, they may still be criticized for flaws, but condemnation is unlikely to be justified.

2. Utilize for agricultural research the model of successful industrial research.

This model recognizes the need to converge the "bottom up" with "top down" recommendations whereby researchers and administrators jointly assess potential values of research initiatives on the twin bases of needs and scientific potentials for meeting needs. The model includes the concept of "corporate integrity" which requires agricultural scientists and their administrators to understand and be sensitive to priority perceptions of higher officials, but the concept also requires these officials to communicate and interact with agricultural scientists, keeping dictation to reasonable minimums.

It also recognizes that the "need to know" is a more compelling incentive to most scientists than the "desire to know".

3. Scientists, individually and collectively, should be considered as scientific entrepreneurs rather than as scientific servants.

The better the scientist, the more options he or she has available. They try to correlate their scientific talents and interests with opportunities and needs that are both significant and challenging. Scientists are willing to participate in planning and program improvement processes, and they are willing to accept administrative decisions if they have been party to their formation.

Over-planned research has some of the same characteristics as over-planned economics, one of which is that they look better in government offices than they really are.

4. The USDA and universities carrying responsibilities for meeting needs of agriculture on a continuing basis should develop reward systems that recognize contributions to agriculture as well as contributions to scientific understandings and in proportion to the significance of each. The reward system should include useful imputs to team efforts.

Parent universities of State agricultural experiment stations may need to reconsider their reward systems more than the USDA. Those universities have grown in size and diversity faster than has their State station. The reward system for research has become based on contributions to science and for scholarly outputs, and is usually measured by numbers and quality of primary research papers. Some kinds of research may contribute importantly to an agricultural advance, but may not result in many papers. Since the reward system is a very important incentive to scientists, it should recognize that his contributions to agriculture are as important as his contributions to science.

5. The Federal government should recognize all the legitimate forces that agricultural scientists must respond to.

The two most overlooked forces at the Federal level to which agricultural scientists and their administrators are responsive are (1) the segments of agriculture for which they have responsibility and (2) the influence of scientific peers. The problem stems from the nature of production agriculture. It is diverse, decentralized, and very environmentally dependent. It is difficult (and probably impossible) to orchestrate research responses to all of agricultural needs, in the right proportions and in the right places, from Washington, D.C. Since budget prospects are always limiting, it is not surprising that only a few of the largest problems or categories which are most politically compelling are the only survivors in the budget process.

Unheard and unseen become a number of other problems and needs which individually are of lesser importance but which aggregatively may be more important to American agriculture than the "biggies" which can be funded. If political leaders in Washington see program shifts in ARS and use of new Hatch funds and shifts in their use as meeting such needs, thus complementing the major new or changing thrusts blessed at top levels, then the two categories will compliment each other for the benefit of agriculture.

It should also be kept in mind that farmers whose problems have not been solved have many ways to bring appropriate pressures on research institutions formed and funded to help them solve their problems. There are few research situations where the users of research have such influence on the researchers as in production agriculture.

The overlooked part of the peer process is that in agricultural research the peer influences include expertise in agricultural situations as well as in the scientific disciplines. In reviews of journal papers, in research planning meetings, in interactions across state lines, and in all other ways scientists interact and react to each other, the twin dimensions of agriculture and science are intertwined.

If the leaders in the Federal government recognize the validity and significance of research user reactions and of the peer influences, there probably will be less concern when the total system responds less than totally to federally determined priorities.

B. Influence of Agriculture and Its Constituencies

Improvements of stimulative forces can be maximized by a clearer understanding of expectations and responsibilities of the various organizational entities of agriculture and its constituencies. There needs to be open, constructive, fully participative dialogue on a relatively frequent basis among agricultural scientists, administrators, and policy makers to consider the constantly changing expectations of science and society. Further, there must be mutual understanding as to institutional and organizational responsibility in carrying out the array of agricultural activities encompassed by the whole. It must be recognized that the total job is too big and all encompassing for any one organizational entity to assume the entire responsibility, if it intends to maximize the output potential of the highly specialized talents of its professional employees. We are living in an age of specializations of the highest order rather than "generalists". This fact demands that talents and resources within organizational entities be identified and that the community of public and private institutions and agencies determine which is best prepared to do what. Within this concept there must be recognition that publicly appropriated funds for research and education, both federal and state, include specific employee responsibilities who share in the allocations. While extension services have a mandated responsibility to carry out the education function of advising farmers and other clients of the applied uses of new research knowledge and technology there must be recognition of the educational interest by private companies. Any industrial product provided for farmers as an agricultural input rightfully includes an obligation of full service guidance which the private supplier is best prepared to handle. This should encourage a sharing of educational responsibility by the Extension Service and the agricultural industries.

During the early history of this country most of the agricultural research of benefit to farmers was conducted by public research and agricultural institutions within authorizations and appropriated funds provided by the Federal and State Governments. However, as our founding fathers envisioned, during the evolutionary development of any enterprise there would be incentives for private entrepreneurs to become actively involved. Consequently, for more than half of this country's history private interests have made immense advancements in research and development in the field of agriculture. Some of the earlier ones include the cotton gin, Cyrus McCormick's reaper and commercial fertilizers. Others followed as the commercial potential showed opportunities for making research and development investments which would yield profitable returns. The private sector deserves high commendation for its effectiveness in developing, producing, and merchandizing the array of agricultural chemicals needed during the past 50 or more years of farming. Also, the private companies have led the way for 40 years or more in developing improved corn hybrids and cotton varieties. Varietal development activities for other crops were undertaken as industry felt prepared to do a creditable job of meeting farmer needs. There are occasional suggestions that the public sector agricultural research and educational agencies completely divest themselves of applied breeding such as development of improved crop varieties and hybrids. However, most companies and public entities recognize the continuing need for state agricultural experiment stations of the Land-Grant universities to pursue enough applied and basic plant breeding and supporting plant genetic, disease and pest control research to assure a dependable flow of newly trained scientists to fully meet the empolyment needs of all State, Federal, and private research and development agencies and programs. This academic training and apprenticeship experience provides for a lasting and lifetime kinship which enhances scientific motivation regardless of the organizational affiliation during a person's career as an agricultural research scientist, manager, or administrator.

Most agricultural research is long-range. Thus, if it is to deal effectively with emerging changes, certain research initiatives need to be started well in advance of the time the results may be needed. Understandably, when considering the total agricultural research needed, some thrusts concern macro and others micro sectors. For example, the cooperative thrusts on the possible eradication of the boll weevil, a major insect pest of cotton, involves Federal and State regulatory and research agencies, Extension Service, State Departments of Agriculture, and farmers. Certain basic research programs for development of control and eradication technologies had to precede other aspects of the program. Finally all organizational and private entities had to participate in concert to maximize the hypothesized expected results. The driving forces to solve this monumental national problem are several fold including (1) the reduction of agricultural chemical pesticides used, (2) improving the environment through lighter pesticide use, (3) improving unit yield and production efficiency of cotton, and (4) saving an industry which provides an excellent renewable source of vegetable fibers and thereby reduces the demand and use of non-renewable fossil fuels required in the manufacture of synthetic fibers.

Micro research endeavors apply to the variety development and production problems of minor crops. At this time such crops would include guar, mint, filberts, kenaf, and many others. With current known but important limited uses for each of these, some likely never will be grown in sufficient volume to warrant research investments by the private sector, while others offer important commercial potential in the years ahead. Thus, collectively the agricultural industry and society have a right to expect continuing public research investment until full potential or newly emerging crops can be determined and perhaps realized.

An example of long-range investment without visualizing future needs applies to the intensive research of the late 1930's and early 1940's to develop alcohol from surplus farm grains. The techniques were perfected almost 40 years ago but the real potential of using such grain based alcohol to fuel combustion engines was not recognized until this nation and the world recently came to the realization that apparently the world supply of non-renewable fossil fuels has peaked and soon will begin declining to perhaps virtual exhaustion within the next several generations.

Because of the long-range nature of much agricultural research there is need for more orderly planning both to implement and to terminate specific studies. The latter is critical when terminating inhouse research. Plans for such termination should reflect sufficient lead time to assure orderly transition of manpower and other resources involved into higher priority research to be pursued in harmony with the needs of all cooperating entities and in manners completely free of disincentives to careers and characterized by incentives for rewarding innovative research scientists, managers, and administrators.

The future "growth and state of the agricultural industry" of the U.S. rests largely on the effectiveness and the dependability of incentives employed. To more clearly understand the importance of such forces contemplated it must be understood that each likely should be based on the primary assumption that continuing improvements in productivity and production of American agriculture is of prime interest to the public, to consumers and, thus, to federal and state governments.

It is further assumed that continuing improvements in American agriculture will depend mostly on improved technologies that must be economically, socially, and environmentally accepted and functionally operational by the users. This includes the fact that expression of need is not enough. Improved technologies to meet growing needs for food and fiber will depend on research capabilities that can assess needs and opportunities and which envisions and carries out scientifically feasible approaches and pathways to new and improved technologies that will meet needs and create new opportunities.

There are two levels of public accountability developing in agriculture as in other sectors important to the public.

One level includes public pressures to improve the effectiveness of research to serve the needs of agriculture; mostly those forces come from agriculture itself.

Research, though not totally satisfying demands at this level, is used to and can accommodate and respond to most of the pressures. The higher level deals with the context of agriculture in the larger fabric of development and activity in the U.S. Here the public pressures create as much dilemma as direction. One dimension would hold research accountable for all technological outcomes and uses in agriculture, good and bad. A more extreme view is that research is not only responsible for technological outcomes in agriculture, but also is accountable for all major side effects. The authors believe public policy makers will need to consider these dimensions more in the future than has been done in the past. However, we urge the new policies in those directions be developed so as to not constrain the research programs serving agriculture directly and not limit agriculture progress toward larger production and improved efficiency. It would seem that separate research efforts should be mounted to assess the larger interactions, and their causes, factor their relative importance and determine which portions of government might need to deal with them.

Corollary assumptions include:

> Existing research units of the USDA and the state agricultural experiment stations constitute the primary publicly supported research resources for agricultural improvement, and their contributions warrant continued support. Detailed attention is not given to the research programs of the sixteen 1890 Colleges and Tuskegee Institute primarily because the Congress has provided for their institutional integrity to carry out agricultural research, and their federal financial

support has been tied proportionately to Hatch funding. Those institutions have made substantial progress in the short time they have had access to meaningful levels of support. They have some additional needs. They very much need additional funds for research facilities. However, leaders from those institutions are in the best position to express their needs to the Congress and to the Executive Branch.

A state tax dollar is just as important to the taxpayer as a federal tax dollar.

Interactions among state stations and between them and the USDA can produce more value from the total public investment than if each research entity operates separately.

Recommendations:

1. Improve understanding of needs and opportunities that can be met by research (state and federal scientists) and extension alone and what will require interactions with other forces of the private sectors, government and nature.

The prime base requisite for effective use of incentives is improved understanding of the agricultural sector and its components, the forces affecting these, including their interactions and how research can provide improvement, with due regard to all potentials and limitations. Only in this way can the expectations for research be kept in reasonable harmony with the probabilities of useful and significant delivery.

2. Improve forecasting and assessments of changes in the micro and macro sectors of both short and long-range agricultural research and the forces affecting each.

3. Adopt credible procedures to sense and assess the changing profiles of private R&D and to obtain advice from R&D leaders in agricultural industries and firms.

For proprietary and other reasons, private industry may never expose their total efforts in R&D. However, if they can be encouraged to describe the boundaries between private and public R&D and how they are changing along with their views and justification for what they believe warrants public support, then public judgement can be more certain that attempts to prevent duplication with private R&D doesn't leave necessary research unfunded.

Private R&D is being extended to include basic research in some of the larger agricultural firms. Interactions between leaders of those programs and public research counterparts will enhance cooperation and reduce chances of unnecessary overlaps in programs.

4. Examine regionality in a more comprehensive sense so that agricultural commonalities across state boundaries can be more effectively dealt with by state and USDA research.

5. Improve joint research planning processes at all appropriate levels and effectively relate planning to program and budget decision processes, state and USDA.

C. Influence of Government

Truly cooperative research involves a partnership in which all participants contribute to the resource and facility requirements, none gouge the others for indirect costs, and all stand to share mutual benefits from the envisioned results. In some instances selective one-time or short-term funding may be desirable or required.

When planning cooperative programs with regulatory and action agencies, all participating entities are encouraged to provide lead time to interact sufficiently to mutually develop effective stragegies. This helps to assure that authorized research agencies can provide the research surveillance needed for the regulatory and action agencies to effectively carry out their supportive research programs in timely, cost effective, and environmentally safe manners.

When pursuing cooperative ventures it behooves all cooperators, whether the effort is totally research or research and regulation, to examine the major accountability forces to determine if individually, interactively, or aggregatively they complement one another or involve some deterrents or roadblocks to effective research performance. Should there be problems, they should be resolved in advance by research managers and administrators so as to assure that the scientist can devote full time to the conduct of assigned research. This can be done only if the research managers have assured maximum flexibility for responsibly and authorititively managing resources--manpower, funds, and physical inputs--to facilitate making sound and timely decisions on research program expansions, adjustments, or shifts.

Recommendations:

1. Encourage improved partnership processes among the states and between the states and the USDA.

2. Adapt selective funding processes to accomplish specific purposes through grants and cooperative agreements.

Some should be used to strengthen and utilize the USDA-State partnership.

Grants and cooperative agreements have been used in many ways in the past to join the scientific capabilities of one or several state research partners with a USDA purpose to meet an agricultural need. Many of these require special and even long-term investments by the state cooperating institution, which cannot be totally justified to its state legislature if the research is intended to benefit the agriculture of several or many states. Therefore, where appropriate, the value of strengthening a USDA-State partnership in the longer-range interests of serving agriculture may be as important to consider as the internal purpose of the grant or cooperative agreement.

Program, financial and accountability procedures should all be consistent with the partnership principle. Sharing of resources should be determined by the purpose of the research effort in each case and the circumstances of the scientific, physical and financial resources of the collaborating institutions. General guidelines, federal and state, should be followed except as they need to be modified to fit a given circumstance.

These requirements will be more important with grants and cooperative agreements intended to achieve long-range institutional commitments for staff and physical facilities.

Grants and cooperative agreements to accomplish purposes through collaboration between and among state research institutions and between selected members of that group and counterpart units of USDA should be the responsibility of the director of the state cooperating institution. In that way resources can be shifted to meet changing requirements of the research.

3. The USDA should continue to attract and enlist capabilities of scientists outside of the agricultural research system.

The Congress has made provision for this important dimension through the competitive grants authorization in Section 1414 (b) in P.L. 95-113. This authorization has proved adequate for the relatively new competitive grants program in several important categories of basic research.

Research leads arising from such programs will have to be transformed and translated toward applied needs and opportunities. Total reliance on competitive grants for such purposes may be too simplistic and self-limiting.

4. Capabilities of colleges and universities other than Land-Grant universities which have agricultural facilities should be utilized but in ways consistent with policies of the states in which they are located.

Those colleges and universities have scientific and physical resources that can contribute in special ways to needs of American agriculture particularly in the areas where they are located. The federal outreach to their capabilities will have to be crafted, however, in ways that are not inconsistent with the policies of the states which sponsor them. The federal government should not encourage other colleges and universities to set up agricultural units for the primary purpose of obtaining federal agricultural research funds.

5. More emphasis should be placed on grants for developmental purposes.

Some new technologies will require developmental research to insure their usefulness. Some may also require associated research to fit the technology into practical agricultural contexts. Energy efficiency in production agriculture is an example. The new or improved energy technology has to fit into enterprises of individual farmers. Primary and secondary research may have to be done simultaneously to adapt the technology to practical farm situations.

There may be a number of organizations and institutions who can test a given developmental technology. There are far fewer who can perform the necessary additional research to refine and adapt the developmental technology to practical uses, taking into full consideration the circumstances and perspectives of the users.

6. Encourage interactivity on a mutual support basis between government action and regulatory agencies and research institutions and agencies, especially where their interaction can serve common purposes.

Some purpose of development and change can be accomplished through full mutual interactions between action agencies and research institutions. This would especially be true where a number of factors need to be considered together to identify best all-around alternatives and to select the best of those for implementations.

This point is mentioned, because of the difficulties in the federal government to join the activities of units that are organizationally distant (different departments or under different Assistant Secretaries in the same department), particularly if the activity is of limited scope.

7. Encourage continuing early lead time interaction on a mutual support basis between federal programs to assure that authorized research agencies can conduct any specialized research and can provide the research surveillance needed for federal regulatory agencies to effectively carry out federal agriculture regulatory programs in a timely, cost effective and environmentally safe manner.

8. Achieve appropriate balance between long-range and shortrange influences on research.

The budget processes, federal and state, tend to favor the short-range needs primarily because they can be articulated more precisely. The long-range requirements for effective research may grow in proportion because of increasing complexities plus the fact that further advances will be more difficult to achieve. The dimension of research feasibility, as it has become in long-range industrial research, will require more sophisticated and sustained attention.

9. Examine major accountability forces and make appropriate changes to assure that individually, interactively, or aggregatively they are not deterring effective research implementation and performance in the long run as well as in the short run.

Research managers need assured flexibility to responsibly and authoritatively manage resources (manpower, funds and physical inputs) and to facilitate making sound and timely research program shifts and adjustments.

10. Encourage a greater commitment of federal funds for support of agricultural R&D. Availability of such funds in recent times have not kept abreast of inflation or with the increase in the national GNP.

11. Maintain a sufficiently strong core of multidisciplinary federal food and agriculture scientists to assure effective surveillance and coordination of the extramurally funded research, and to provide a continuum of credible federal research programs on high priority national and regional research missions and problems.

12. Guard against expanding federal agriculture contract and grant funds at the expense of inhouse research programs.

D. Influence of Parent Universities

Parent Land-Grant Universities of the state agricultural experiment stations are key to formulating academic policies, establishing credibility and utilizing funding mechanisms that contribute to an atmosphere that encourages and stimulates its research managers and scientists to achieve useful purposes. University and experiment station administrators should continue to examine the institutional-employee relationship policies with the objective of making timely changes and improvements essential to maintaining a dynamic participative growth and reward system for its professional and scientific staffs. Specific attention should be given to advancing opportunities for research fellowships, visiting professors and scientists, seminars, lecture series, sabbatic programs, official travel to scientific meetings, awards for outstanding achievements, and competitive salary and retirement plans. Also critical is a budget development and fund allocations policy which assures a fair share of funding for food and agricultural research.

Recommendations: 1/

1. Improve understanding and recognition of the responsibility of the SAES to the agriculture of the state and the value to the parent university of providing effective service to the state's agriculture.

2. Improve the recognizability of the SAES needs in budget and appropriation processes, in part, to reflect needs of the State's agriculture and rural life.

3. Seek improvement of organizational and administrative procedures to enhance fulfillment of SAES responsibilities to the State.

E. Influence of Professional Societies and the Scientific Community

Research scientists, managers and administrators are readily identified with and generally impart a dedicated allegiance to their employing organization, institution, association, corporation, or industry. Their day-to-day activities and concerns in such employment usually incite some level of stimulation and provide opportunity for professional growth. Despite this, there is a desire and need for individuals to establish and maintain a broader based affiliation and influence. This is fulfilled in some measure by active participation in professional societies that best represent and reflect their field(s) of academic training, professional experience and interest and in many cases common purposes for their research. Generally, professional societies are highly effective in promoting and upgrading the fields of science they represent without getting involved in any of the partisan, territorial, or parochial attitudes that sometimes permeate the public, private, and volunteer agencies that provide the primary outlets for employment.

Professional and scientific societies in agriculture represent expertise in agriculture and science. Thus, their inputs, reactions, assessments, etc. can consider both dimensions at once. The societies can identify and encourage "best expertise" groupings that can address issues larger than individual scientists can react to alone.

So long as professional societies represent and foster the professions represented in non-partisan unbiased manners, they can be extremely influential in helping to improve institutional and organizational management and administrative policies and procedures. Effective means for planning, and action committees of the society; sponsoring or co-sponsoring broad-

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1/ The same points are relevant for 1890 College agricultural research programs and those of cooperating veterinary and forestry schools.

based symposia and conferences on timely national and international issues which crosscut the interests and scientific disciplines of many employing agencies and scientific societies; and a ready willingness to participate in identifying ad hoc groups from the society or a consortium of societies to make objective, unbiased special studies and program analyses as might be requested. Within these frames of reference, professional societies can be extremely helpful in shaping policies and procedures which will maximize opportunity for development, growth, motivation, productivity and mobility of research scientists, and to upgrade the professionalism of science, all of which are critical to the vitality and viability of all employing entities and their employees.

Recommendations:

1. Improve utilization of peer expertise in planning and carrying out agricultural research programs, projects and individual experiments.

2. Involve professional societies to help identify and encourage scientists to participate on committees, to prepare analysis and status papers, and to assess problem and opportunity areas, and assist in developing policies and programs that have important scientific dimensions.

3. Encourage professional societies to foster intersociety activities that contribute to agricultural research planning, processes and utilization of outcomes.

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Part B: Determination of Food and Agricultural Research Priorities

I. Priority Setting Processes in the State Agricultural Experiment Stations--Keith Huston

II. Forces Affecting Food and Agricultural Research Decisions--Ron Knutson, Don Paarlberg, and Alex McCalla

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IV. The Process of Setting Priorities for Food and Agricultural Research--Charles E. French

Commissioned Paper I

PRIORITY SETTING PROCESSES IN THE STATE AGRICULTURAL EXPERIMENT STATIONS

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FOREWORD

To meet needs of readers with limited knowledge of agriculture and its publicly-supported research system, I have prepared two background chapters. They briefly describe the history of State Agricultural Experiment Stations and the setting in which priorities are determined. More knowledgeable readers may wish to limit their reading to Chapters III through VI which deal directly with priority setting processes.

SUMMARY

Priority setting is a dynamic, everchanging, and complex activity of State Agricultural Experiment Stations. It guides allocation of scarce resources in the development of research programs to meet local, state, regional, national, and international needs and concerns. With the exception of a few recently created Stations, most Stations have been setting priorities to develop research programs for 60 to 100 years or more. Priority setting in Stations with operational research programs composed of high priority investigations means reassessing current programs in the light of changing needs and emerging new needs. Priority setting now, in the past, and in the future, is an activity guided by federal and state legislative mandates.

A. Legislative Mandates

There have been five major recurrent thematic mandates. The first general mandate (Hatch Act of 1877) is for research to serve the needs of people. In response to that mandate, the Stations have developed unique processes for securing opinions of actual and potential users--the people--about their needs.

A second mandate delineates the scope, purposes, and duration of the research and is succinctly stated in the Act of 1955 Consolidating the Hatch Act and Laws Supplementary Thereto, as follows:

> "It shall be the object and duty of the State agricultural experiment stations ... to conduct original and other researches, investigations and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the United States, including researches basic to the problems of agriculture in its broadest aspects, and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contribution by agriculture to the welfare of the consumer as may be deemed advisable, having due regard to the varying conditions and needs of the respective states."

A third mandate, reflected in the last phrase of the preceding legislative passage and in countless state legislative actions, is to serve the varying conditions and needs of the individual states. That theme has been reinforced repeatedly by actions of state legislatures which provide most of the Stations' research support.

A fourth mandate delineates the characteristics of the research itself. In the Hatch Act of 1877, basic, applied, and developmental research, in today's words, and their natural relationships were implicitly described as part of the Stations' mission.

A fifth mandate, repeated in Congressional actions at irregular intervals during this century and most recently reemphasized in the 1977 Farm Bill, is to coordinate state and federal research so as to maintain a highly efficient and productive national research system.

Among these mandates, two ("researches bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the United States" and "having due regard to the varying conditions and needs of the respective states") have molded the organizational and operational structure of State Experiment Stations and their priority setting processes.

B. Maintaining A Permanent and Effective Agricultural Industry In Face of Continuing Change

Maintaining a permanent and effective agricultural industry is not a static assignment. The United States constantly changes. Its population grows continuously and changes its demands of agriculture. Its concerns over natural resources used principally by agriculture and the quality of its environment have changed and significantly affected agriculture. Its economic opportunities have and will continue to change; agriculture is and will be a principal contributor. Clearly these forces alone speak to the need for innovative and responsive agricultural research.

Even more critical is the nature of agriculture itself. Agriculture involves complex dynamic biological and economic systems. Change is a constant feature. To maintain a permanent and effective agriculture is to win over and over again myriads of fixed battles with unrelenting forces of nature. Productivity gains are not permanently self-sustaining. Food and fiber supplies cannot be viewed as the automatic product of an economic demand-supply equation. If the

United States is to maintain a permanent and effective agricultural industry, it must have a permanent and effective agricultural research system. But how can such a permanent system, built as it must be on the creative efforts of specialized scientists, operate effectively when change is so evident and research is by nature a slow, cumulative process? Do priorities change so rapidly as to require important modifications in the research system every few years?

C. The Agricultural Industry of States

Fortunately, the agriculture of most states in terms of the sciences and scientific disciplinary specialists needed to solve its problems is much more stable than unstable. Agriculture, of course, differs from most sectors of the Nation's economy. It is permanently and naturally dispersed across the entire country, with production of individual food, feed, and fiber commodities localized by climate, soils, rainfalls, and economic circumstances and advantages to specific areas. Each state produces its own special mix of various food, feed, fiber, amenity crops, and livestock. This mix is largely the result of interplay among historic, economic, social, natural resource, and climatic factors. Variation among state and among localities within states is a principal reason for the decentralized organization of agricultural research. Not only does each state have its own State Agricultural Experiment Station but each Station also has branch stations or outlying locations located strategically around the state.

What often is not perceived is that this localization also dictates an appropriate structure for research priority setting. An aggregative "bottoms-up" process is most effective. Needs are identified for small agroclimatic and economic areas and aggregated to larger and larger areas.

In addition to this need for decentralized research, the general need of all producers, irrespective of their location, is for research to enhance their competitive advantage in production and marketing of commodities they produce. To accomplish that, research may focus directly on improving production, processing and marketing, or on improving service, supply, transportation, credit, policies, and other issues on which the production-marketing chain depends. Those common needs create many similarities in staffing patterns, research programs, and priorities of State Experiment Stations. But similarity is neither identity nor duplication, for the research is undertaken to satisfy the specific needs of each state. The number of commodities and specific commodity-related problems, the problems of rural home and rural life, and the needs of consumers in every state far exceed the research resources available.

D. Principal Priority Setting Concerns

Hence, priority setting in State Experiment Stations is concerned not only with identifying current and future research needs of users, but also with acquiring resources to meet those needs.

The first and most obvious priority of all Stations is to maintain an appropriately balanced staff of research scientists, a responsive organizational structure, and sufficient flexibility of resources--both human and material--that both continuing and changing needs can be addressed. In all but the recently established Experiment Stations, that priority was first addressed many years ago. Resources--both human and material--have been apportioned and reapportioned repeatedly among commodity and natural resource needs roughly according to the economic importance of the commodity, number of producers, acreages, severity of problems associated with the commodity, or to the nature and costs of research on that commodity problem. Resources apportioned to rural home and community research have largely been determined by legislative direction in each state.

E. Specialization--A Growing Concern in Priority Setting

The knowledge base in each agricultural science continues to broaden and increase in complexity. These trends force scientists to specialize more so as to achieve a working mastery of topics crucial to solution of user problems. This growing specialization means that the number of different scientists needed to solve the same range of user problems must continually expand or the range of problems must be reduced.

Specialization of that degree also means that each individual scientist is more likely than anyone else to know what his research efforts can yield in solving user problems. And that establishes him as a base for specific priority setting as contrasted to general priority setting of Stations and departments which relate to commodities and other collective issues encompassed in user needs.

F. Priority Setting Processes

Priority setting processes are continuous input-feedback activities, largely self-adjusting. In these activities, needs and wants are identified by the people of the State and responses are initiated by the Stations in an appropriate fashion.

G. Steps in Priority Setting

Priority setting by Stations has four major steps. First is to identify the research investigations and research programs of greatest need and value to the State, its people, principally the users, and to the Nation. Second is to examine the scientific and practical feasibility of those investigations relative to the resources available or required. Third is to set priorities with due consideration to needs and to feasibility of the germane research. Fourth is to respond by taking up and completing those investigations given priority.

H. User Needs Identified

Producers, their suppliers and marketers, processors and manufacturers, and the State Experiment Station exchange ideas and opinions continuously through hundreds of channels. Though this automatic and natural system is highly effective, more orderly and systemic processes of identifying user needs and changing priorities have been developed both by users and by Stations. They complement the natural system and coalesce the needs and ideas of tens and hundreds of users into groups, kinds, or types of needs. Priorities are narrowed to those of greatest urgency or importance.

Among the formal mechanisms created by the Stations, one can identify Station, college, and departmental advisory groups; agricultural councils; listening meetings; Station research days, open houses, field days; Extension-derived input; and a host of others. Virtually every Station and its branches engage in numerous activities that provide users of research and other people of the State easy access to scientists so that needs can be expressed.

Informal mechanisms are another route. Throughout each year, numerous groups and individuals visit the Stations, call administrators or scientists, write letters, or send resolutions or priorities to the Stations relative to their needs and problems.

But user demands are great and often conflicting. Thus, Station administrators and scientists must understand not only the nature of user concerns but also their common characteristics so as to set short-range and long-range priorities most profitably.

Users' overarching concerns are with their immediate and specific problems. But the immediate and specific problems of one year may not be those of the next year or a decade hence. Research, from its initiation to its adoption, often takes eight to ten years. So Stations must view immediacy in a longer-range context and balance that against future needs. Specificity usually requires localized research conducted by scientists of many disciplinary specializations. That need must be balanced against the broader needs for comprehensiveness--the ability to address many other major problems elsewhere in the State. Other characteristics include integratability, continuity, innovativeness, and accessibility.

From their efforts to address user needs and from an understanding of their common characteristics, Stations have developed relatively complex internal priority setting processes.

I. Internal Priority Setting Processes

As noted earlier, most Stations already have ongoing research programs composed of high priority investigations. So the steps followed in priority setting involve reassessment of current programs in the light of changing or emerging needs. While there is a division of labor in Stations with respect to priority setting, Stations generally operate in a collegial mode that differs from the hierarchical mode of their USDA counterparts. This is done not only because of the intensity and diversity of specialization required to solve problems, but also because it places greater emphasis on individual initiative, creativity, and productivity by scientists.

In general, broad priorities for agriculture and related missions are set by Station administrators, often with department heads serving as an advisory council. Resources are allocated to science departments of the Stations (e.g., Field Crops, Soils, Animal Sciences, Agricultural Economics).

The departments, in turn, set priorities as they relate to the more specific concerns of user needs, naturally a responsibility of that department.

All departments must maintain an appropriate or "critical" array of disciplinary specialists. In multicommodity departments, the array must include enough disciplinary specialists of each kind to meet needs of each commodity. In addition, departments must provide investigations with sufficient human and material resources to move them as rapidly as feasible. In a sense, each investigation requires a "critical" mass of resources. These are major concerns in departmental priority setting.

In the departments, each disciplinary specialist after appropriate consultation with colleagues and administrators sets his priorities. He establishes them in terms of research opportunities that will contribute to meeting agriculture's needs. He is encouraged to seek scientific aid and counsel without concern for departmental structure.

Where several departments share in responsibilities, they set priorities jointly.

Station priority setting processes may involve horizons of time, program resources, personnel resources, faculty resources, experimental resources, state resources, federal resources, and many others.

Throughout the priority setting processes, Station scientists and administrators constantly seek and utilize input about user needs.

State Experiment Stations have been able to address state problems more comprehensively by sharing in the employment of scientists with the Land-Grant Colleges of Agriculture and State Cooperative Extension Services. Alone, most Experiment Stations would be forced to hire scientists and supporting technicians on a full-time basis as is characteristic of USDA research agencies. But, by sharing, they can hire on a part-time basis many more disciplinary specialists. They also gain intellectual and resource flexibility through the use of part-time graduate research assistants who are engaged in graduate education in the College of Agriculture and others. Additional resource flexibility is gained by sharing laboratories, barns, fields, experimental plots, sophisticated and expensive equipment, and other physical resources. Because the USDA has stationed many of its scientists at or near Experiment Stations, these scientists become an integral feature in Station priority setting. These benefits accrue because the Experiment Stations are located with and are a part of the states' land-grant agricultural system and because the state legislatures have concentrated these functions in a single institution.

Despite this sharing, many problems require specialized talents of scientists not employed by the Stations. The location of Stations in universities provides them access to many other scientists. Another avenue is scientists in other State Stations and the USDA.

The latter option resulted in mechanisms through which several Stations and the USDA agencies join in solving common problems. It also has produced mechanisms for coordinating state, regional, and national research.

J. Regional and National Priority Setting

Effective regional and national priority setting mechanisms were first made possible by the Research and Marketing Act of 1946. It created the Regional Research Fund (RRF). Before that, Stations had neither significant funds nor state authorization for travel and coordinative work. In conjunction with the RRF authorization, State Experiment Stations strengthened their four regional associations. Through numerous technical and administrative committees and task forces of these associations, Stations and USDA agencies mutually conduct and coordinate research addressing regional and national needs. Today more than 200 committees are actively engaged in collaborative research and in jointly setting regional and national priorities.

In 1972, under the auspices of the Agricultural Research Policy Advisory Committee (ARPAC) jointly sponsored by the USDA and the National Association of State Universities and Land-Grant Colleges, a Regional and National Agricultural Research Planning System was initiated. It was based largely on recommendations of a 1966 National Program of Research for Agriculture Study also conducted by the USDA and the State Agricultural Experiment Stations. This planning system enables USDA research agencies, State Stations, and other cooperating institutions to exchange ideas about priorities and needs. It also facilitates collaborative research efforts.

In 1977, the new Farm Bill created a Joint Council on Food and Agricultural Services. It is to aid coordination among federal agencies, State Agricultural Experiment Stations, State Cooperative Extension Services, Land-Grant and other colleges engaged in research, extension, and teaching in agriculture.

K. Differing Responsibilities and Priorities of State Experiment Stations and USDA Agencies

Research responsibilities of various publicly-supported state and federal agencies and institutions cooperating with them differ as do their priorities.

The State Experiment Stations must provide research programs balanced to meet each state's needs. They also address most regional and national needs automatically. Collectively they comprise much the largest and broadest-based agricultural research entity in the country.

The USDA agencies (SEA's Agricultural Research and Human Nutrition, Economics and Statisitcs Services, and the Forest Service) are smaller, special mission agencies.

SEA's Agricultural Research, the largest of these, focuses principally on agricultural research. Parts of its programs are integrated into Station activities because AR scientists are located at or near State Experiment Stations. Others are not. Comparison of the national program of the State Experiment Station System with that of AR reveals many differences and some similarities in priorities. For example, cotton and fruits are the commodities receiving greatest attention in AR, whereas fruits and vegetables receive greatest attention in the Experiment Stations. Principal national efforts in improving biological efficiency of field crops and in livestock improvement are concentrated in the State Experiment Stations. Comparison of AR research programs conducted in individual states with those conducted by the State Experiment Station of the State reveal clearly that AR addresses a few state needs in conjunction with its regional and national efforts.

Parts of ESS programs also are integrated into Station activities because ESS scientists are located at or near State Experiment Stations. But this is largely a byproduct of ESS's efforts to meet its national responsibilities to provide economic information and statistical data for decision making.

INTRODUCTION

Priority setting is a dynamic, everchanging, and complex activity of State Agricultural Experiment Stations through which they attempt to allocate scarce resources in response to state, regional, national, and international needs, concerns, and opportunities.

Domestically and internationally, pressure for greater food production will intensify in the next two decades. If that food is to be produced, research must provide the means. Research also must focus on conservation of natural resources and on maintaining a quality environment. The state-federal United States Agricultural Research System, already the most effective system in the world, is expected to respond both by enhancing the already highly efficient United States production and by providing greater leadership, training, personnel, and guidance for many developing countries of the world. The State Agricultural Experiment Stations have a vital role. They are the largest and broadest component of the state-federal research system and the principal supporter of graduate research programs that produce nearly all the Nation's Ph.D. agricultural scientists and many of those from other nations as well.

The capacity of most State Stations to respond to the challenges confronting agriculture has been constrained for nearly two decades. In many states it has eroded. This is a consequence of changes in the nature of research demands and in factors affecting the quality of the research system to supply research results.

On the demand side are two major changes. First, food producers and other users of research, who once had several options for maintaining and improving their economic positions, now find research discoveries to be a primary option. That is reflected in the intensity and frequency of their demands for research and their rapid adoption of new discoveries. Second, environmental, health, social, and regulatory responsibilities related to agriculture have been expanded. The users and the performers of research, the Stations, have been required to redirect some resources to these concerns and away from increasing food production efficiency and developing new food production opportunities.

On the supply side, the Stations have been faced with inflation, higher labor and equipment costs, and the expanding needs of ever more sophisticated and complex agricultural sciences as these sciences continue their efforts to master the unknown in each science. The needs are of three kinds: (1) for greater specialization, which requires more individual scientists and their support personnel to work in the new and developing subdisciplines within each science, (2) for more, and often costlier, instrumentation and other resources (principally land, equipment, greenhouses, and numbers of livestock) to permit use of more powerful experimental designs that can yield more reliable answers to research questions, and (3) for new kinds and areas of research. Future technological advances are likely to be more difficult to achieve. Greater research inputs will be required for each unit of advance.

State legislatures in many agricultural states have kept pace in advancing resources for research. Others have not, as is true also of states with less dependency on agriculture as a source of revenue. The Congress, despite its repeated efforts to overcome United States Department of Agriculture budget recommendations (which have emphasized other issues than the opportunities for economic gain through research) has lagged behind in providing appropriations.

Such are the circumstances under which research priorities of the State Agricultural Experiment Stations have been set for a number of years and are now being set. Despite the somewhat austere picture in some states, all Stations continue to identify principal state and national needs and to address them effectively and optimistically within the available resources.

This paper focuses on priority setting processes of the Stations and their relationships with current programs, staffing, resources, and recent trends in resource funding.

PART I - THE SETTING

In 1887, the Congress established a unique partnership between the federal government and the government of each Sate when it agreed to share in the creation of a State Agricultural Experiment Station in each State and supported it thereafter. At that time, the United Sates Department of Agriculture already was engaged in agricultural research of special concern to the Congress and the Executive Branch. Thus, the dual state-federal United States Agricultural Research System was created. It is still the only such state-federal research system in the United States even today.

In retrospect, it is gratifying that the Congress and the state legislatures were so far-sighted as to recognize in that early era that food, the primal element in human survival, must be a mutual and continuing concern of both--that state and national concerns were so intricately interrelated and interdependent as to be inseparable. Food is produced in those parts of the United States where land, water, climate, and economics will permit it to grow. The fact that the Nation's daily bread is produced principally from wheat grown in just five prairie states and its citrus fruits by just four or five states elsewhere in the Nation does not make wheat or citrus fruits simply the concern of those few states which can produce them. And the same is true for many other foods in the American diet.

In recognition of this inextricably-joined commonality of interests, the state-federal United Sates Agricultural Research System operates with both partners offering mutual assistance to each other. The Congress appropriates funds on a formula basis to each State. The states, as a minimum, match that investment, though most independently invest two to twenty times as much. The states, through Cooperative Agreements (not grants or contracts), house USDA scientists in state facilities at no cost to the federal government, and provide them funds, support personnel, library resources, research laboratories, plot lands, greenhouses, and access to cooperating state scientists and major equipment and service of facilities. The states also have provided and continue to provide land on which federal laboratories are built near state installations so as to further the mutual cooperation and efficiency of the dual system. The USDA has reciprocated on a much smaller scale.

Today, that partnership often seems uncertain and, occasionally, in jeopardy. That uncertainty about the strength of the federal commitment to the partnership has a significant effect on priority setting processes in the Stations, requiring as it does, contingency plans to deal with whatever exigency may arise.

Despite those uncertainties, the Stations continue to respond as they have for nearly a hundred years to the mandates of both state and federal governments. Those mandates, simply stated, are to serve the needs of the people of the State and the Nation with principal emphasis on the needs of agriculture, including conserving its natural resources, and the needs of the people of the rural areas. To serve the people, the Stations from the very beginning sought to involve users of research in helping set priorities for research. Over the years, the Stations have continuously modified the processes by which priorities are established so as to serve more effectively the needs of the people and their times.

It is difficult to count all the users of station research discoveries much less to involve them all individually in priority setting processes. Although the three million or so persons engaged in agriculture and related industries clearly are the primary users of agricultural research discoveries, there are countless others whose lawn grasses, shrubs, vegetables, fruits and shade trees were developed by the Stations; who prepare, preserve, and consume foods in accordance with recommendations based on Stations' discoveries; and who utilize other less obvious features of Station research. And, of course, all United States citizens ultimately are "users" of agricultural research discoveries because they consume food and benefit from the improved balance of trade brought by farm exports.

Though it is impossible to involve every user in priority setting processes, user input about research needs and user feedback on the utility of research discoveries are important in guiding Station research. To this end, Station administrators and scientists try to provide users easy and continuing access to the resources of the Station through a variety of formal and informal entries. That process is enhanced by the fact that most Experiment Station scientists have agricultural backgrounds, have close ties with Extension Specialists, speak the language of the principal users, and moreover, are within a phone call or a day's drive.

Because there are so many individual users and because each user easily can identify numerous researchable problems of special personal concern, Stations attempt to aggregate problems into classes or groups of problems on the basis of commodity, area, special concern, or scientific discipline, and to involve representatives of those classes of problems in the priority setting process. Even with that group representation, the number of problems far exceeds the resources available in the Stations.

Choosing among so many priorities is one of the most crucial and complex activities in the Experiment Station. Obviously topics selected for research, among other things, must be those of greatest importance or economic concern or potential to the most users and the State, those most likely to contribute to enhancing food production and other societal goals, and those most amenable to solution by knowledgeable scientists and with available resources.

CHAPTER I

NATURE OF USERS' NEEDS FOR RESEARCH DISCOVERIES

In this chapter, attention is given first to the way in which Stations identify general and specific needs of users in each State and then to a distillation of common characteristics of user needs.

A. General Needs of Users

Each State has its own special mix of various food, feed, fiber, amenity crops, and livestock enterprises. This mix is largely a product of historic, economic, social, natural resource, and climatic factors that determine which plants, crops and cropping systems, livestock and livestock systems can be produced successfully year after year in competition with other states and nations. It is the aggregate product of decisions made by thousands of producers in small states and hundreds of thousands of producers in large states.

The general need of producers is for research to enhance their competitive advantage in production and marketing of commodities they produce. To accomplish that, research may focus directly on improving production, processing and marketing, or on improving service, inputs, supply, transportation, credit, and other issues on which the production-marketing chain depends. Apportioning research resources among the commodities in the mix, roughly according to their economic importance, number of producers, and acreages in the State should assure, in a crude way, that general needs of all users are addressed.

Most states have been divided into sub-county, county, or multi-county areas or "agro-climatic" locales in which the mix of commodities is smaller or more distinctive than in other areas of the state. Varieties of plants, types of insects, weeds, diseases, and other pests and their importance, and supply and marketing institutions for plant and animal commodities are highly location-specific. In many states, conditions are sufficiently homogeneous in an area involving six to ten counties that they may be considered a unit. (Figure 1 illustrates the intensity of localization in crop production as viewed by Iowa economists.) In other states, they are not. Nevertheless, in many states, commodities of major importance to the State are produced in virtually every agricultural county. From a research perspective that means that research must focus not only on the mix of the commodities from a statewide perspective, but also on the differences among locales that may affect all aspects of production or marketing of the commodities.

The commodity mix of each State, though more stable than unstable, has changed in the past and likely will change in the future. These changes sometimes are subtle and represent only changes in locales or in specialization within locales, but sometimes they are profound, representing massive increases in one commodity at the sacrifice of another. These changes must be accommodated in priority setting; many can be anticipated but some cannot.

The commodity mix varies from state to state although adjacent state are more likely to have a similar mix than those more remote from each other. But similarity of commodity mixes does not imply identity, for local differentiation is a universal characteristic of the agriculture of all states.

The kinds, acreages, number of producers, and importance of various commodities in each state is available in agricultural statistics of that state or in national summaries (see for example: "Agricultural Statistics," published annually by ESCS, USDA).

B. Specific Needs of Users

Whichever the state, most users can readily identify their individual research needs and priorities in terms of solving specific problems, e.g., controlling insects, higher yielding varieties, greater reproductive efficiency. Most arise out of the particular crop and cropping systems, livestock and livestock systems on a specific farm in a specific area with a particular soil, rainfall, climate, and topography. That specific farm and others are part of a unique marketing and supply structure from which needs also may arise.

Few users are in positions of such broadbased leadership as to be able to experience needs of the State, Region, or Nation. Users know best what they need today and usually perceive less clearly what they will need in the future.

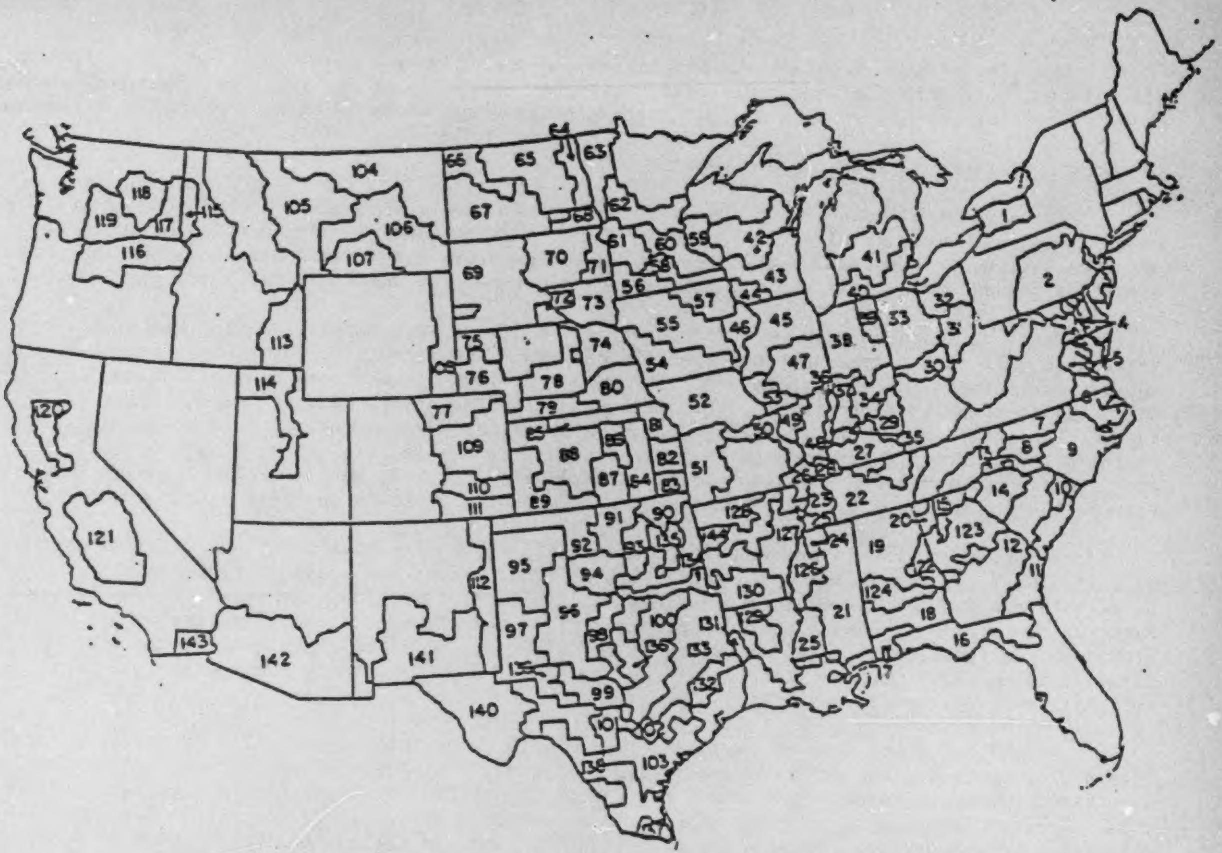
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Figure 1. 160 crop-producing regions of the United States. (From "Projected State and Regional Resource Requirements for Agriculture in the United States in 1980," Research Bulletin 568, Iowa Agriculture and Home Economics Experiment Station, Ames, by Leo V. Mayer and Earl O. Heady.) Note: Crop production specialists of several states have advised me that crop-producing regions of their states must be subdivided further for agronomic purposes.

User input about problems and priorities and user feedback about usefulness of research discoveries, both potential and real, must be weighed carefully as one important component in the priority setting processes, with due recognition being given to both its weaknesses and strengths.

C. Common Characteristics of User Needs

Station administrators and scientists who work closely with users are able to identify characteristics common to all users' needs. These characteristics are factors to be included in priority setting processes. Users' overweening concerns are with research discoveries that answer specifically and immediately their current problems--immediacy and specificity are all-important.

Doers of research know well that next year and each year thereafter the users of those years also will expect immediate and specific answers. Research answering today's problems may not provide answers for tomorrow's problems. And that issue is the most vexing problem in user-doer relationships in research priority setting: balancing priorities of today and of the future. In attending to future needs, doers, having limited resources, often must sacrifice some degree of specificity in responding to current needs. When specificity is not attainable, applicability of research is an appropriate, though less desired, substitute. Extension must rely on the ingenuity of users to adapt applicable results to their specific circumstances.

Beyond the needs of immediacy and for specificity, users have other needs. Results must be reliable, i.e., research must be reproducible. That search for reliability often causes scientists and Stations to be quite cautious in prematurely revealing new research discoveries. Farmers, accustomed to unsubstantiated promises of success from other sources, are sometimes perplexed by the "conservatism" of certain Station scientists. On the other hand, those same farmers, faced daily with conflicting claims, have expressed repeatedly their gratitude for the reliability of Station recommendations.

Research results must be capable of being integrated into a particular production, processing, or marketing and distribution system. Virtually all users of research deal with complex, integrated systems of production, which may reoccur in cycles extending several years. Doers of research often investigate only one element in a complex system. Integratability of that research into the system must be a concern of doers. And the agricultural background of scientists and their close association with users facilitate that integration.

Users, despite preoccupation with immediate needs, also are concerned with having a continuing flow of discoveries; continuity of research is significant. Thus, a grant research system that is on-and-off again, that starts and stops, is not an appropriate base system, but is a useful supplemental system when there is an adequate base. While continuity of research brings with it a stream of gradual changes, the user also wants to sense novelty or originality; innovativeness, the hope for some undreamed of discovery, is another element.

Although there is a high degree of specialization among individual users of research in all of agriculture and the food industry, most have need for access to a broad range of research that parallels the diversity of their operations. Comprehensiveness--encompassing most concerns of users--is another element. Piecemeal or fragmentary approaches or unarticulated approaches are less believable and less readily adopted.

Lastly, accessibility of research is a significant feature. It is not the accessibility of the library or of the distant scholar who might provide answers were he asked. It is the daily accessibility which comes from personal acquaintanceship, from information transfer facilities, from proximity of user to research location and discoveries, and from the sense of ownership as a taxpaying citizen that is needed.

D. Orienting Science to User Needs

Legislation in Behalf of the People

In 1862, the Congress passed the first of several extraordinary acts which led to the establishment not only of the Land-Grant Colleges of Agriculture, and subsequently the State Experiment Stations and State Cooperative Extension Services, but also to a common philosophy that was to guide their activities. They all were to serve the needs of the working classes who were then engaged principally in agriculture and industrial arts. Thus, service was inextricably tied to the people, the users.

In the intervening years, that philosophy of serving the "common" people has been steadfastly maintained as a central concern of these units. Without delving into the history and evolution of each State Agricultural Experiment Station, it is difficult to comprehend the subtle but important differences in their structure and organization and responsibilities that influence the way in which they respond.

The Land-Grant System

Virtually all State Stations are associated with, or are an integral part of, the State's "land-grant" college of agriculture and also are associated with the State's Cooperative Extension Service. All "land-grant" colleges of agriculture (or, in some states, schools of agriculture) are part of a larger state university. About 3/5 of those universities are the principal, general-purpose state university of that state. The remaining 2/5 are state universities that originally were colleges of agriculture and mechanical arts but now have grown into a second of two principal multi-purpose universities in those states. In these universities, agriculture was once the central reason for their existence. Now, agriculture is only one of many important reasons. (Only one Experiment Station and one land-grant college now are a part of a private university, though several were originally.)

Scientists Who Serve the People

Although all state university scientists see themselves as ultimately serving the needs of the people of the state, perceptible differences exist in the attitudes and approaches between scientists employed by the Experiment Station and those not employed by the Station.

Perhaps the greatest differences are in orientation and responsibility. Both the university professor and the Experiment Station university professor share allegiance to their academic peer group, their professional society, and to the academic community in general. The Experiment Station professor, however, is expected to respond to the needs of the people outside the university. His research is directed to their needs. He is expected to confer with farmers or other agricultural groups, to speak at meetings sponsored by the Experiment Station or the Extension Servive or by other public agencies; if funds are available for travel, to travel to the far reaches of the State on problem-solving missions. And unlike the university professor, this traditionally has been without additional compensation.

In a sense, the university professor seeks scientific discovery for the sake of science, whereas the Experiment Station professor, who also has this as a professional goal, seeks to make his research respond to the needs of the people of the State.

This difference in perspective is a natural one. By and large, the university professor depends on educational resources of the university allocated to support graduate training programs and on grant or contract support from the federal government. His research thus responds to the needs of his scientific discipline but may bear little relationship to the immediate needs of the state.

It is interesting to compare the attitudes of agricultural scientists in other public agencies with those of Station scientists. The contrast between USDA research scientists and Experiment Station professors is somewhat less great. Most USDA researchers are full-time researchers whose research efforts are hierarchically managed. They, like other researchers, work generally within their subject matter competency and personal interest, but are subject to greater directional change and influence from administrative superiors. Those who are stationed at State Experiment Stations in or near agricultural departments usually respond freely to requests for assistance and accept speaking engagements and related activities within the State or region. For most, their exposure to the public is less than the exposure of their counterparts, the Station scientists.

Those stationed elsewhere in the State usually operate independent of the Station. When their research bears on the needs of the State, as it often does, its results are incorporated into extension programs of the State. Often times, results find their way into State programs largely through their contribution to the advancement of a scientific discipline, a slower route to public use.

Several special federal initiatives in research (those in forestry, rural development, the 1980 Land-Grant Institutions, and animal health) involved the faculties of some state

Stations with those of other state and private institutions not in the Agricultural Experiment Station System. Aspects of those programs conducted through the State Agricultural Experiment Stations differ little, if any, from usual Station operation. The attitudes in other cooperating institutions largely reflect the previous experience of the investigator or the general nature of the institution, department, or unit with regard to previous research experience, focus, and emphasis. Some investigators, accustomed to federal grant procedures, operate as if they were under that system. Those who have not previously engaged in any thing other than Ph.D. research, if even that, often mirror the attitude and approaches of their major professors elsewhere. The traditional notion of broad public service of the Experiment Station often is not held by these investigators. Many have had only limited research experience.

The Experiment Stations' emphasis on orienting science to the needs of people and involving people in identifying problems and setting priorities is extremely important in making research a vital part of the daily life of those people. It is also a significant element in the Stations' abilities to secure continuing support from state legislatures in order that they may meet the people's needs. Since the Sputnik era, state legislatures have been besieged with general and special requests from the universities, state agencies, and groups of citizens to support many different kinds of research, including numerous requests to support "basic" research. Although many have responded in a modest way, most have been extremely selective in their choices. Indeed, some of the research supported by federal agencies has been at one time or another proposed for state funding.

CHAPTER II

EXPERIMENT STATIONS: ORGANIZATIONS BUILT TO MEET USER NEEDS

The Experiment Stations, because of their long history, have evolved in organization and function in continuous response to changing user and State needs. In general, the staffing and nature of research closely follow the nature and economic importance of the commodity mix, the number of producers, the acreages, the State's educational needs, and the special and critical agricultural problems of the State. Though resources have never matched fully the many needs of the State and the Nation, the Stations have been able to respond more effectively and sensitively to the enormous variety of developing needs than have other research organizations. This response results from the Stations' own special characteristics, from their close linkage with a land-grant college of agriculture, and a State Cooperative Extension Service, and from their associations as part of a major research university.

Experiment Stations typically include a Central Station and headquarters at one location and a number of Branch Stations or other outlying units located strategically around the State. In most states, the majority of the Station scientists are at the Central Station. The name "Station" evokes for many persons a bucolic vision of scientists surrounded by experimental fields, orchards, barns, flocks, and herds. In many states, the scientists are in university buildings and most experimental units are some distance away, no longer on campus.

A. The Experiment Station and the Land-Grant Universities

The Central Station of all but a few State Agricultural Experiment Stations is on the campus of the states' largest or second largest multi-function state university. The scientists of the Stations are members of the faculty of the university. And the Station gains from that association because it provides access to many hundreds and often thousands of Ph.D. scientists, specializing in hundreds of disciplines, whose services and counsel are easily available. It also provides access to major university facilities such as libraries, computers, machine and electronic shops, analytical laboratories, and many other costly and highly specialized units. It provides an intellectual environment in which issues of concern to all segments of society are aired. Because most of these universities are among the leading research universities in the country, the association provides access to the latest research advances in sciences related to agriculture.

Multiplying Research Talents

The association with the Land-Grant Colleges of Agriculture and the Cooperative Extension Services provides a flexibility and breadth to research programs that can be gained in no other way. One of the critical problems facing State Experiment Stations is in having sufficient scientists to man the new and emerging subdisciplines of the agricultural sciences and to provide the specificity of research results so greatly cherished by users. These problems are critical to undergraduate and graduate education in agricultural sciences and to Extension Services as well.

The three units--research, extension, and resident instruction--by careful planning and coordination are able to share the specialized talents of a large number of scientists by employing them on a part-time basis for Experiment Station research, for collegiate instructional activities, and, less frequently, for Extension duties, or any combination of two. Thus, an Experiment Station which employs 150 full-time-equivalent scientists may actually employ 250 or more part-time scientists and thereby gain 100 additional intellects and scientific specializations. But, of course, this will add to the Station's total output only as the dual responsibilities may complement each other and the output of individual scientists may be greater through cooperative efforts.

Another benefit from this relationship comes in sharing the cost of support personnel, administrators, and administrative services, and in sharing resources employed only seasonally or for parts of the year.

Station research programs also benefit greatly by the expansion of their options for employing scientific talents made possible through the graduate education programs at the Master's, Ph.D., and post-Ph.D. levels, principally in agricultural sciences but also in other related sciences.

There are also some occasional disadvantages. Scheduling of instructional activities can interfere with research. Some research programs are so important that the full-time efforts of a lead scientists are critical to the success of the program. Some scientists are most successful in managing their time when they have only one principal responsibility; some may be most suited for instructional activities. Also, resources intended for research may drift to support scantily supported instructional activities. University administrators may view instructional activities as the most important activity of the university and may give priority to them. University administrators also may view the usually separately budgeted Experiment Station and Extension Service resources as providing instructional faculty in colleges of agriculture with more resources than are available to faculty elsewhere in the university. And that may affect the allocation of teaching resources to the instructional programs in agriculture. Lands of the Experiment Station close to the offices and laboratories of the Station scientists may be needed for instructional or recreational facilities for students. But with careful management and the reasonable attitudes usually held by principal administrators of the university, the advantages outweigh the disadvantages.

The university and the students also gain from the location of the State Agricultural Experiment Station on the campus. In many states, the Station has provided access to resources not available elsewhere in the university. These include statisticians and biometricians, skilled in the design and analysis of experiments, who can aid the other university scientists in using their resources more effectively. Also, many pieces of specialized equipment available to Station scientists are available to other university scientists. But most important of all, the university gains from the additional scientific breadth and from the down-to-earth pragmatism and concern over needs of people outside the university community that the Experiment Station usually brings. The university gains also from the association with the USDA scientists who are stationed on the university campus because the Station is there.

B. The Experiment Station: Its Resources and Organization

Scientists: The Principal Resource

The principal and most important resource of each Station is its array of scientists in numerous departments, each with his own disciplinary specialization and special competencies within that discipline. Because the agriculture of each State is relatively stable, the array of sciences and of disciplinary specializations required to address agriculture's needs also are relatively stable.

Each Station has evolved its own unique array of scientists, commensurate with its resources though often not commensurate with user requests. That array varies from state to state in many ways. Maintenance of the array is a continuing, almost permanent priority of all Stations. Two major factors are involved. One is meeting user desires for specificity, immediacy, comprehensiveness, and continuity. The other is meeting the needs of agricultural sciences as they necessarily subdivide into additional and more complex specialties.

Because the Central Station of most State Experiment Stations is located on the land-grant university campus and is an integral part of the university, the organization of scientists into units closely follows the departmental organizational structure of the university, paricularly the college of agriculture, with certain exceptions. In some states, Branch Stations and other outlying units are considered departments. Scientists stationed there are members of that department. In other states, the scientists at outlying locations are members of departments in the Central Station of of the college of agriculture, when the Station faculty has been integrated into the college. Program direction may be provided from either the Central Station or the Branch Station. Other state idiosyncracies also exist.

Sciences

Research at the Central Station is usually conducted by Station scientists in those departments or units having responsibility for Field Crops, Soils, Horticultural Crops, Plant Pathology, Ornamental Crops, Entomology, Animal Sciences, Veterinary Sciences, Agricultural Engineering, Agricultural Economics, Rural Sociology, Food Sciences, Human Nutrition, Home Economics, Forestry, Biochemistry, Agricultural Genetics, Agricultural Microbiology, Statistics, and Biometry. In some Stations, sciences dealing with the general organization and functions of plants, animals, humans, and microorganisms at the organismic, cellular, and subcellular level also may be included, when they are not already a part of a traditional agricultural department.

In many Stations, Wildlife and Fisheries and other natural resources and environmental sciences (meteorology) are included. In addition, some Stations have research efforts in Chemistry, Physics, Mathematics, History, Political Science, and a number of engineering departments other than Agricultural Engineering.

The research departments and the names, disciplinary, and subdisciplinary specializations of Station scientists in those departments are listed annually for each State Agricultural Experiment Station in the handbook, "Professional Workers in State Agricultural Experiment Stations and Other Cooperating State Institutions," published by Cooperative Research, Science and Education Administration, USDA. One can see in that publication the many differences among states. The research programs and resource commitments of each State Station are published annually as a regular activity of the Current Research Information Service, a computerized information retrieval system, sponsored jointly by the U.S. Department of Agriculture and the State Agricultural Experiment Stations. By collating the State statistical information available in "Agricultural Statistics" and State statistical publications with the above information, one can readily perceive the nature and organization of research programs in each State. One can also see the similarities and differences among states.

At the Branch Stations and outlying locations, agricultural sciences are principally the production and protection sciences.

In some states, functions usually the responsibility of the State Department of Agriculture and other state agencies have been assigned to the Experiment Station. These include such units as Soil, Feed, and Water Quality Analysis, Statistical Reporting, Veterinary Diagnostic labs, Plant Disease labs, and others.

The Station as a Responsive Organization

Though research programs of the Stations are managed in a collegial fashion to optimize individual initiative, the Director has legal responsibility for the funds and programs. He, his associate and assistant directors, and the department heads often form an administrative council that oversees the operation of the Station. But Stations are more than a collection of departments which have within them a faculty and some flexibility of resources that enable them to respond to user needs. Stations are more than a collection of individual scientists independently solving problems of agriculture to provide users with useful new discoveries. The Station is a cohesive unit--a vital organism. It is large and diverse enough to encompass the principal agricultural and related sciences, their disciplines and subdisciplines, needed to answer current and future user needs. It is large enough to take advantage of the opportunity to purchase extraordinarily expensive equipment to be shared by Station scientists. It is large enough to respond flexibly to changing user problems, and large enough to move flexible resources from department to department to resolve multidisciplinary problems. It is large enough to deploy resources widely and judiciously among the agricultural sciences so as to cushion agriculture against the unpredictability of specific scientific advances, and to take advantage of the relative certainty of advances somewhere in the system: a strategy for insuring progress.

"Largeness," as I use it here, is not an absolute term subject to exact numerical description but a relative one, relative to the needs of users and relative to the needs of the departments and scientists who attempt to meet those needs. This largeness, or capacity to respond to change, is possible only because both the state legislatures and the Congress have provided continuing sources of funding which may be allocated by the Station to further the states' agriculture. In recent years, the USDA and the Congress have favored USDA intramural research programs over those of the partnership. Most important of all, the Congress has failed to maintain its historic commitment to an equally funded state-federal partnership through formula finds in a time of extraordinary inflation and rising costs. The Congress has introduced new programs that attempt to rearrange the statewide roles and reponsibilities of the Experiment Stations, assigned by the state legislature. The USDA has initiated a grant program, created from formula funds intended for the Stations. Such actions have diminished the stability and flexibility of the Stations and the effectiveness of the partnership.

These actions are being felt in every Experiment Station in the country. Most wonder how far and how many of the user needs for specificity and immediacy of research must be sacrificed in an era when growth in agricultural productivity, long the model for other sectors of the Nation's economy, is steadily diminishing. What will be the consequences in the next 20 years? Will food prices rise sharply as a consequence? Is famine to be accepted in other countries?

Careful reexamination of the nature and needs of agricultural sciences in the light of these changes only reaffirms that their needs are real, substantive, and that progress is dependent on meeting those needs. There are no short cuts.

The Needs of Agricultural Sciences

Modern agricultural sciences build on the knowledge and thought and error accumulated by previous generations of science. Most sciences advance slowly, steadily, but in directions that often cannot be anticipated. Occasionally that slow advance is altered by an avalanche of discovery that moves one or more disciplines or subdisciplines precipitously forward. Some such advances prove useful throughout many sciences; others prove useful only to a single subdiscipline. Each, though, brings a renewed sense of excitement, of enthusiasm, of vigor, and of optimism. This is important for Nature gives up her secrets only grudgingly even to the brightest and most creative scientists.

Advances often depend on a sequence of experiments, some requiring three to five years, and each adding to that of its predecessor. In many fields of science, research can be done indoors where many variables can be controlled to isolate the importance of a single factor. In most agricultural fields, such an approach is at best fragmentary and sometimes deceiving in its isolation.

As the knowledge base in a discipline broadens and becomes increasingly more complex, scientists specialize more and more in a relatively narrow area so as to achieve a working mastery of those topics that seem crucial to advancement of the field. Like all humans, scientists vary in their ability to master one or more specialties contributing to their own science, in their ability to perceive new opportunities for discovery, and in their tastes and aptitudes for research in various subdisciplines of their own discipline. Not all have the patience or persevereance of the plant and animal breeders who require 7 to 10 years to develop a new variety, or 10 to 15 years to develop a new fruit cultivar, or 15 to 30 years to conduct an animal breeding experiment. Nor do all have the aptitude or desire to engage in a career in laboratory research, no matter how short the duration of laboratory experiments or how rapidly they may furnish new leads.

Most agricultural sciences deal with complex interactions of genetically diverse individuals, races, species, genera of useful plants, animals, microbes and their pests in the continuously changing outdoor environment of Nature and differing production systems of farmers.

Agricultural biological sciences differ from general biological sciences in three major features: (1) they deal principally with agricultural and related species of organisms; (2) they seek to manipulate the biology of those organisms and their individual and population interactions in ways useful to man, and (3) they must manipulate within economically and socially feasible options.

All biological sciences may be investigated from either a reductionist or a holistic approach. The reductionists are interested in reducing the life processes of an organism into their smallest component parts--their chemistry and physics. The holists, on the other hand, are interested in understanding the whole of life processes of organisms, populations of organisms, and their interactions with other organisms and populations as they occur in nature. Neither approach is more "basic" than the other. After all, one cannot deduce from an understanding of the operations of an internal combustion engine, the highways to be followed by an automobile propelled by such an engine. So it is with biology.

Since the early 1950s, understanding of biology has advanced most rapidly at the cellular and molecular levels rather than at the organismic or population leveles. Unfortunately, those advances have distorted perception not only of biological scientists but also of educated policy makers. "Basic" research has come to mean research of "reductionists." Overoptimistic claims have been made; caution has been thrown to the winds by some. One cannot help recalling in this flood of events that despite the many common features of life processes, the uncommon features are extraordinarily pervasive and obvious. Early biologists recognized these differences and on them built a taxonomic system that classifies living forms into kingdoms, phyla, species, genera, and other groups, a system still of great value today.

It remains to be seen which and how many of the cellular and molecular discoveries can be exploited to man's advantage. One wonders how many of those made in non-agricultural organisms will be exploitable in agricultural organisms and how many must be "rediscovered" directly in agricultural organisms.

More importantly, the remainder of biology--holistic biology -- must receive greater attention if organisms and populations are to be manipulated for man's benefit. Most of that relating to agricultural organisms will come through the efforts of agricultural scientists as it has in the past.

Clearly, the needs of the agricultural sciences impinge on the priority setting process in a number of ways. The most profound way is in requiring long-term manpower commitments in critical areas, employing additional scientists to man newly emerging subdisciplines, or broadening capabilities of an already existing team, or buttressing an on-going effort that would benefit from more rapid advance. Such needs must be addressed from the perspective of the Station as well as from that of individual departments.

The Needs of Departments

The science departments are the principal operational units of the Station and provide day-to-day management of research. They are key units in the priority setting processes. Departments usually have tripartite or quadripartite responsibilities. They are responsible for undergraduate and graduate instructional activities and related scholarly research funded through the university instructional budget; for research of the State Agricultural Experiment Station; for extension activities of the Cooperative Extension Service; and, in many states, for modest international agricultural activities. Thus, the departments have more complex and much broader responsibilities and consequently greater total resources than other university departments. (Many have larger budgets than schools or small colleges in the university.) That complexity and breadth also provide them with greater flexibility, though the degree of flexibility varies among the departments. In some, such as Entomology and Plant Pathology, Experiment Station research is a predominant concern. Undergraduate instruction is a smaller activity than it is in such departments as Agronomy, Animal Science, and Horticulture. In these departments where undergraduate education is a sizeable activity, that activity may cause temporary contractions and expansions in certain Station research activities, and occasionally may even impinge on Extension activities during part of the year, a situation which is generally understood by state legislatures.

The joint appointment of scientists as Station researchers and college teachers is especially valuable in an age of ever-increasing specialization. If affords researchers an alternate means of responding to user needs for specificity and continuity.

Experiments designed to provide results relating to localized or temporary problems often can be performed by students working towards a Master's degree under close supervision of a senior research scientists. More complex issues requiring longer periods of time for their solution can be addressed by Ph.D. students. Both types of graduate training programs are short enough in duration that they enable a scientist to continue his principal research efforts while at the same time providing him the means to engage in a sequence of exploratory initiatives that ultimately may influence the direction of his future efforts. Moreover, the scientist and the departments are able to retain greater flexibility in the use of supporting research funds than would be possible if they had to hire permanent research technicians as is characteristic of research organizations not associated with a university. Departments may expand or contract their research efforts on critical problems by either deploying more or fewer graduate research assistants as affordable or readjusting faculty time assignments. As scientists have become more specialized, departments now find they also must have generalists who can integrate research discoveries into systems.

Most departments have achieved a reasonable capacity to address broad needs of users, but most still lack the resources or scientific staff to deal with more specific needs as effectively as they would like. In many states, the mix of commodities or the number of agro-climatic areas is so diverse that departments can only respond by assigning individual scientists the responsiblity for several commodities or areas, thereby reducing their ability to deal with the individual needs of each. The problem is particularly acute in horticultural crops.

The Needs of Scientists

Individual scientists in Experiment Stations differ widely in their needs for support of their research efforts. Virtually all can efficiently use the services of one or more research technicians and several graduate research assistants, though most rarely have more than one or two. Most require frequent support from scientists in two or more other disciplines and access to a much larger number less frequently. Their needs for physical resources are enormously diverse. Some require only modest investments in laboratory equipment and supplies. Others require animals, experimental plots, greenhouses, and highly specialized equipment only intermittently; some, permanently. Some require huge supporting investments; others, only modest investments. These needs and differences play an important role in priority setting and illustrate the importance of involving scientsts in priority setting.

The Needs of Outlying Units

Early in the history of State Agricultural Experiment Stations, the users' needs for specificity caused by problems and opportunities associated with variations in soils, climate, rainfall, and other factors gave rise to the establishment of Branch Experiment Stations, outlying fields, and other research units located away from the Central Station. These outlying units, created before the Extension Service in many states, also served as a site for demonstrating sound agricultural practices, a responsibility they continue to share (but which is now integrated) with Cooperative Extension programs.

In many states, the number of these stations increased sharply in the late 1940s in response to user needs. But the costs of operating so many locations competed with the need for additional specialized scientists. In most states, the number of locations has been reduced to a minimum that can provide sufficient specificity of results as to make them reasonably applicable over a number of counties with only slight modifications. User needs for specificity likely will always exceed the resources of and for Branch Stations to meet those needs.

Branch Stations typically are managed by a resident superintendent. In most states, scientists employed at the Branch Station reside there. In all states, the research programs of the Central and Branch Stations are closely coordinated. In some, principal responsibility for the scope of the research program lies with the Branch Station faculty. In others it is shared with the faculty of the Central Station. In some, it is completely determined by the Central Station's faculty. Most Branch Stations have only relatively simple supporting laboratory facilities and must rely on the Central Station to meet their analytical laboratory needs.

Branch Stations often must generate from their agricultural operations sizeable fractions of their operating resources. This causes them to be like typical area farming or production operations and enhances the acceptability and transfer of research findings. It also insures that research scientists and administrators of the Central Station are exposed to the important issues facing producers. But it also reduces the ability of Branch Stations to contribute to the advancement of scientific disciplines to the extent possible at the Central Station.

Special Units

Special research needs common to many departments have caused Stations to create special units that are available to all Station and most university scientists. These units include feed mills; laboratories, for equipment such as X-ray machines, computers, scanning and transmission electron microscopes; for chemical analytical services; for electronic equipment manufacture and repair; and for remote sensing, hormone analyses; and others. The size of the Station and the nature of its total research program are important elements in determining the number of such units. Because some research activities in many agricultural sciences now can be mechanized, scientists' requests for equipment far exceed resources of most Stations. Sharing is an important element in meeting scientists' needs; special units are one mechanism.

In many land-grant universities, the Experiment Station has provided biological and physical scientists outside the Station access to sophisticated equipment.

Federal Agencies and Other Cooperating Institutions

In research on crops and soils, there long have been very closely-knit cooperative relationships between the State Agricultural Experiment Stations and the SEA's Agricultural Research (AR). About 500 SEA scientists are stationed in Experiment Station buildings. A reverse exchange exists in that 100 or so Station scientists are housed in USDA facilities.

There also are a number of special purpose AR research units on Experiment Station campuses, some housed in Station buildings and others in AR buildings built on land donated through the Station by the State.

AR scientists hold courtesy ranks in the Experiment Station departments and are free to participate in departmental and Station activities.

Station programs are built around full utilization of the productivity of these scientists. If efforts by AR scientists or units can effectively serve user needs in that field of specialization, no state supported scientists will be employed. If, however, the manpower commitment by AR is inadequate for state needs, additional state scientists will be employed. Even when AR units are remote from the Central Station, state programs are developed around those efforts. This joint endeavor permits the State Stations to meet user needs more fully by adding to the diversity of scientists available and by broadening the range of problems the Stations can address.

About 20 percent of ESS scientists are housed at or near Experiment Stations. Much ESS work in the Stations is done by Station economists on cooperative agreements, contracts, or grants. While the relationships between ESS and many agricultural economics departments have been close, those with the Station administration in most cases have been more distant.

Within the State, cooperation with other agencies and universities depends largely on the role those agencies and universities play in the organization of state activities. In most states, research in agriculture and related areas is limited solely to the State Experiment Station. Teaching responsibilities may be divided among several institutions.

New Federal Initiatives Bring New Participants

Four recent federal initiatives have introduced new relationships among and within certain universities. The first of these, the McIntire-Stennis Act, provided for strengthening and expanding forestry research.

The second was appropriations to the land-grant colleges of 1890 and Tuskegee. In most states now, cooperative programs and priority setting have been established by the State Experiment Station Directors and Coordinators of Research in the 1890 Schools. A few state legislatures have provided funds for very modest research programs in the 1890 Schools. In most states, the state legislatures have been unwilling to provide funds for a separately budgeted research operation duplicating the states' major research efforts at the State Agricultural Experiment Station.

The third, Title V of the Rural Development Act, involved joint research and extension activities. In each state, a few carefully chosen small rural development projects were initiated. Expansion to a broader range of problems was prevented by limited funds.

The fourth, Animal Health research, funded under Title XIV of the 1977 Farm Bill, broadened research in animal health. In most states, that research was conducted by veterinary and animal science departments of the State Agricultural Experiment Stations or by departments in colleges of veterinary medicine, either from Station or college resources. Administration of the new Title XIV funds was arranged by administrators of the State Experiment Stations, colleges of veterinary medicine, and appropriate department heads. In many states, the expansion of animal health research was integrated into Experiment Station programs. In some states, principally those with veterinary colleges, the responsibility for projects funded in the veterinary colleges was retained by the administrators of the colleges.

PART II - THE PROCESSES

CHAPTER III

IDENTIFYING CHANGING USER NEEDS AND THEIR PRIORITY: CONTINUOUS PROCESSES OF INPUT AND FEEDBACK

Each year in every state, users register their needs and priorities for research discoveries in countless ways. Most do so simply and directly--by using or not using the discoveries. Consider, for example, the adoption of new varieties, strains, or cultivars of grains; oilseed, fiber, and forage crops; vegetables; fruits, ornamental shrubs, and turf grasses released each year by the Stations as one of their major research responsibilities; the adoption of new techniques for controlling weeds, diseases, and other plant and animal pests, or for more effective marketing procedures and strategies. The initial trials and the subsequent acceptance or rejection of these discoveries are commonplace events which measure some user needs and priorities and demonstrate not only the fulfilled needs but also those remaining to be filled. An agriculturist needs only to drive along rural highways to see what has happened, is happening, and has not happened that might have.

Continually across the state, county newspapers, radio and television programs, and monthly farm and producer organization magazines report the research discoveries, the adoption, and the advantages and disadvantages of those discoveries as voiced by the adopters. In annual meetings of local, county, and state producers, suppliers, and marketing organizations, of which there are many in each state, participants discuss problem solutions and opportunities for change. And, above all else, there is a continuing exchange of ideas and opinions among producers, their suppliers and marketers, processors and manufacturers, and Station scientists. All live in a competitive, market-oriented, economic world where their very livelihood depends on their knowledge and evaluation of old and new and on directing their activities, the new practices they adopt or reject, to enhance and protect that livelihood.

In that world, communications flow freely and opinions are expressed openly. Through hundreds of channels they return to the Stations' researchers. (Figure 2 summarizes my impression of the nature and frequency of interactions of Station research scientists with users of their research.) Thus, there is little likelihood that user needs and priorities and their changes will not be impressed on the researchers' minds. Though this automatic and natural system is highly effective, more orderly and systematic processes of identifying user needs and changing priorities have been developed both by the users and the Stations. They complement the natural system and coalesce the needs and ideas of tens and hundreds of users into groups, kinds, or types of needs. Priorities are narrowed to those of greatest urgency or importance.

In the section that follows, a number of the most commonly employed processes for identifying changing user needs and priorities is described. Some are formally organized; others, only informally, depending instead on spontaneous actions of concerned individuals and groups.

Figure 2.

Department	Field Days and Tours	Commodity or Industry Meetings	Extension Meetings	Producer, Diagnostic, or Clinical Services	Organized Advisory Groups	Federal Granting Agencies	Legislature	State Granting Agencies
STATION ADMINISTRATION	+++	+++	+++	0	+++	++	+++	+++
PRODUCTION								
Agronomy (Field Crops)	+++	+++	+++	++	+++	+	+	+
Horticultural Crops	+++	+++	+++	+++	++	+	+	+
Soils	+++	+++	++	+++	+	+	+	+
Animal Sciences	++	+++	+++	+	+	+	+	+
Agricultural Engineering	++(+)	++	+++	+	+	+	+	++
Branch Stations & Fields	++++	+++	+++	++	+++	0	++	+
PROTECTION								
Plant Pathology	++(+)	++	++	+++	+	+	+	+
Entomology	+(+)	+	++	+++	+	+	+	+
Vet. Science	+	++	++	+++	++	+	+	[illegible]
Climatology	+	+	+	+++	0	+	+	[illegible]
AGRICULTURAL ECONOMICS	+	++	++	+	+	++	++	++
PROCESSING								
Food Sciences	0	+	+	+	+	++	+	+
FORESTRY	++	++	++	+	++	+	+	+
OTHERS								
Rural Sociology	S	+	+	S	+	+	+	+
Molecular Biology	0	0	0	0	0	+++	0	+
Biochemistry	0	0	S	+	0	++	0	+
Statistics	0	0	0	+	0	++	0	+
Bacteriology	0	0	0	+	0	++	0	+
Journalism	++	+	+	S	0	0	+	0(+)
Human Nutrition	0	+	+	+	+	++	+	+
Botany	0	0	0	+	0	++	+	+
Zoology	0	0	0	+	0	++	+	+
Fisheries, Wildlife, & Aquaculture	0	+	+	0	+	++	+	++

Key:
+++ many interactions
s sporadic and few interactions
0 few or no interactions

Figure 2. Nature and Frequency of Interactions of Station Research Scientists with Users of Their Research.

A. Formal Mechanisms

Advisory Groups

In every state, there are advisory groups of citizens, usually representing organizations, commodity groups, or sections of the state, which are specially involved in the activities of the Experiment Station, the College of Agriculture, the Cooperative Extension Service, or their combined activities, or even the university or state. (Figure 3a lists the advisory groups for the South Dakota Agricultural Experiment Station. Figure 3b lists Oregon Agricultural Research and Advisory Council. Figure 3c lists the Agricultural Advisory Council to Pennsylvania State University.) In those states in which research, teaching, and extension functions of the three units are integrated administratively under the leadership of a Dean or other chief administrative officer, a formally-organized advisory group for all functions often has been created. Those advisory groups range in size from 15 to 130 members. They usually meet on a quarterly or semi-annual basis. In some states, advisory committees exist for each functional unit or for a special activity (e.g. seed production). Generally, the members, whether appointed or elected, as is most common, represent the major general farm organizations, commodity groups, service and marketing groups, and other groups concerned with public issues such as rural affairs and environmental concerns. Terms on the advisory committee normally rotate. Members are predominantly from the private sector.

While practices vary among states, advisory groups usually: (1) review the plans and accomplishments of the functional units involved; (2) review the budgetary needs and legislative askings for programs and facilities; and (3) identify issues, needs, and priorities of the groups they represent.

In some states, such groups are required by law, and their membership may be on an elected basis. In a few states, principally where the Station is not located on the university campus proper, a Board of Control may be appointed by the governor, to be both supervisory and advisory in its activities.

In addition, there are often departmental advisory councils. They, too, usually represent user groups most intimately concerned with the department's activities, including teaching (manpower needs and training curricula), research, and extension. They may meet as frequently as several times a year or as infrequently as every two or three years. Their responsibilities are similar to those of advisory groups discussed earlier.

State User Groups; State Agricultural Councils; State Boards of Agriculture

State user groups typically number from 50 to several hundred. They include general farm organizations, farm supply and marketing organizations, farm cooperatives, commodity groups, specialty commodity groups (such as livestock breed registry groups), food processors, county associations, regional commodity and promotional groups, state banker groups, state conservation groups (soils, water, environmental, fish and wildlife), recreational groups, and many others. In some states, a State Board of Agriculture is responsible for overseeing activities of the State Department of Agriculture and for advising the governor. Other related boards of state government also exist. In most states, boards or commissions are responsible for coordinating joint state-federal programs, such as Soil and Water Conservation, Watershed, and others. Also to be included are the many Extension councils and committees, consumer groups, and others.

Each of the groups meets at least annually. During those meetings, research needs and priorities often are identified, some by a special research committee of the group. At many of these meetings, a representative of the State Agricultural Experiment Station is present on invitation, as a member of the group, or as a guest speaker, and serves as a resource person.

Among those commodity groups which fund Station research, usually through check-off funds, many have a research committee responsible for recommending allocation of those funds and for reviewing the progress of the research. Such committees meet regularly each year with Station administrators to review research pertinent to that which they may wish to fund and to discuss the most effective utilization of their own resources on a priority basis.

Although this interaction between state user groups and representatives of the State Experiment Station usually is arranged formally by either the user group or the Station, the association between the group and the Station representative is often one that has existed for many years. So these discussions about research progress and needs comprise an important, and

Figure 3a. South Dakota Agricultural Experiment Station Advisory Groups

Agricultural Experiment Station
South Dakota State University

93rd annual report

Advisory groups

Agricultural Advisory Committee

1980
Robert Ingle, Cavour
Greg Jorgensen, Ideal
Russell Stone, Gettysburg
Everett Brue, Sioux Falls
1981
John E. (Matt) Sutton, Agar
Arnold Wienk, Lake Preston
Dale Borchard, Redfield
Doyce Friedow, Madison
Mrs. Willis (Joanne) Bieber, Bowdle
1982
Elmo Cain, Lemmon
Roger Hainy, Wessington Springs
Roger Zuehlke, Britton
Gordon Brockmueller, Freeman
Mark Keffeler, Sturgis
1983
Howard Eggers, Philip
Kermit Torve, Rapid City
Glenn Allan Blumhardt, Bowdle,
Paul Thomas, Murdo

Southeast Experiment Farm

Stanley Jensen, Beresford, president
Merlin Peterson, Irene, vice president
Sidney Abild, Wakonda, treasurer
Vane Miller, Yankton, secretary
Lloyd Overgaard, Centerville
Dave Bogue, Beresford
Leon Jorgensen, Freeman
Darrell A. Edelman, Menno
Willie Huebner, Akron, Iowa
Richard Bottolfson, Vermillion
Robert Anderson, Hudson
Joe Uherka, Wagner
Wayne Burkhart, Dell Rapids
Ron Larsen, Beresford

Northeast Research Station

Alvin Solom, Watertown, chairman
Bob Schurrer, Watertown, secretary
John Schwab, Andover
Irwin Symens, Claremont
Robert Quade, Wilmot
Wallace Redlin, Summit
Vernon Singrey, Hazel
Andy Raml, Goodwin
Harold Hurlbert, Raymond

Central Substation

Dick Fadgen, Huron
Doug Meyer, Huron
Ray Larsen, Faulkton
Larry Lindhorst, Faulkton
Wayne Nesby, Miller
Jay Pugh, Miller
Robert Edwards, Pierre
Jerry Hawkins, Blunt
Kenneth Olson, Highmore
Dennis Ruzicka, Highmore
Lawrence Carson, Wessington Springs
Roger Hainy, Wessington Springs
Lawrence Madsen, Gettysburg
Victor Beringer, Gettysburg
Harold Wood, Onida
Doug Marsh, Onida

Antelope Range

Blaine Dragest, Isabel
Dave Fischbach, Faith
Bill Clanton, Buffalo
Gary Gilbert, Ludlow
John Johnson, Sturgis
Mark Keffeler, Sturgis
Ray Meyer, Sorum
Harold Millet, Reva
Leonard Nygaard, Gascoyne, ND

Cottonwood

Ohmer Cook, Philip
Charles Deutscher, Wall
Clifford Fees, Philip
J. Tipps Hamilton, Midland
Harold Ireland, Martin
Harold Odom, Philip
Eugene Thomas, Murdo
Mark Trask, Elm Springs
Neal Brunskill, Philip
Robert (Barney) Pfeiler, Wall

Veterinary Science

Oscar Nygaard, Clear Lake, chairman
Roy Carlson, Milbank
Harold Nelson, Yankton
Robert Snyder, Groton
Les Zeller, Vermillion
Dr. Duane Hughes, Pierre

Staff

Board of Regents

Dr. Richard C. Bowen, Commissioner of
Higher Education, Pierre
Vincent Protsch, Howard, chairman
Fredric Cozad, Martin, secretary
Michelle Tapken, Menno
Bonnie Sivage, Hayes
Robert Bartron, Watertown, vice chairman
Howard Levi, Aberdeen
William Srstka, Jr, Pierre

Executive

S.O. Berg, PhD, President
D.D. Dearborn, PhD, Dean
R.A. Moore, PhD, Associate Dean and Director
W.A. Bugg, BSA, Director of Finance
R.P. Stohr, Executive Assistant

Station Statistician

W.L. Tucker, PhD, Professor

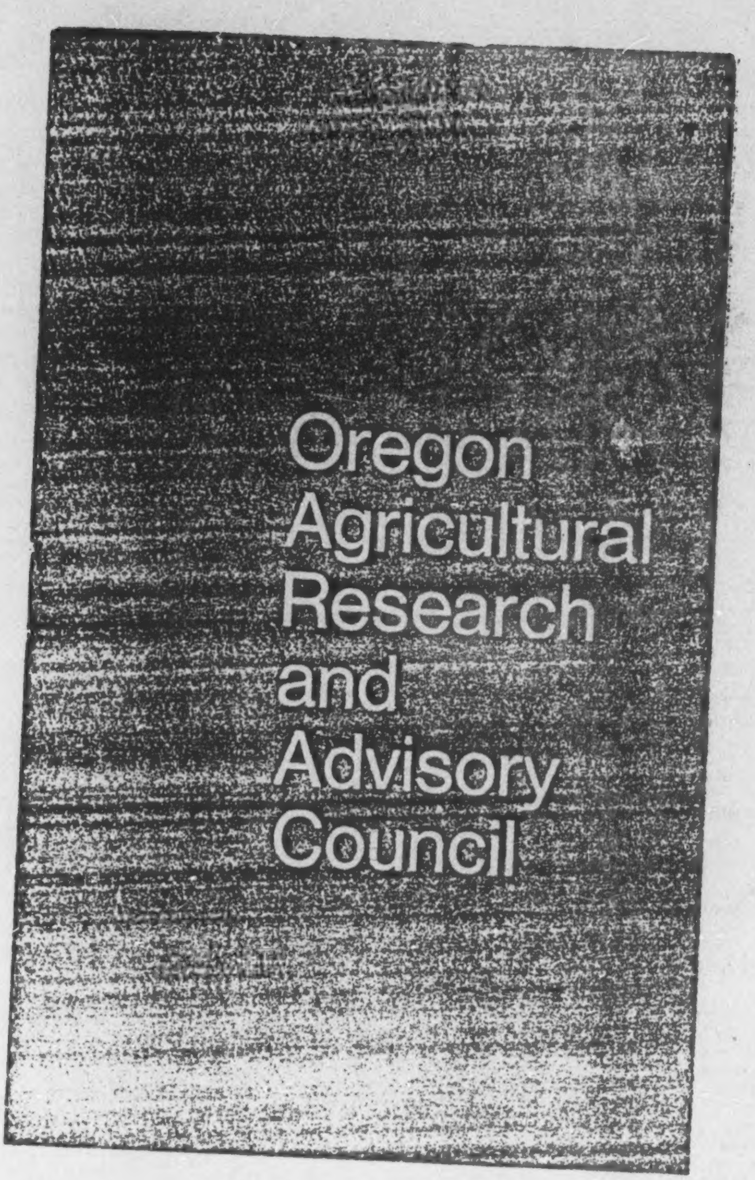
Agricultural Engineering

D.L. Moe, D Sci, Professor and Head
L.L. Christianson, PhD, Assistant Professor
T. Chisholm, PhD, Associate Professor
S.T. Chu, PhD, Associate Professor
D.W. DeBoer, PhD, Professor
A.C. Dittman, BS, Research Associate
A.J. Heber, MS, Instructor
M.A. Hellickson, PhD, Professor
V. Kelly, MA, Instructor
T.M. Klosterman, BS, Research Farm
Superintendent
W.F. Lytle, MS, Associate Professor
S. Papendick, MS, Instructor

Agricultural Information

J.L. Pates, MS, Agricultural Editor
M.R. Brashier, MS, Information Specialist-
Publications
J. Leslie, BS, Information Specialist-Ag News
and Feature
L. Tennyson, MS, Information Specialist-
Publications and Special Projects

Figure 3b



Oregon
Agricultural
Research
and
Advisory
Council

1974

MEMBERS

Animal Health Council

An organization of industry representatives dedicated to the promotion of animal and poultry health of livestock in Oregon. Its purpose is to upgrade research to limit losses in the livestock industry. The No. 1 activity is to work for expanding educational opportunities for veterinarians in the Pacific Northwest. Sixteen producer organizations have representatives active on the council.

Representative: Dudley Sitton, Route 1, Carlton, 97401, 472-6688

Columbia River Salmon and Tuna Packers Association

Principal canners and processors of salmon and tuna on the Columbia River are members of this trade association whose basic objective is sound management of the anadromous fish resources on the Columbia. It also represents the interests of its members in labor negotiations and before government forums on all levels.

Representative: T. T. Bugas, 1608 Irving Avenue, Astoria, 97103, 325-3556

Northwest Food Processors Association

Members are persons, firms, partnerships, associations, or corporations in the business or directly associated with food preservation or the manufacture of fruit and vegetable juices in Oregon, Washington, Idaho, or Montana.

Representative: Dave Pahl, 2828 SW Corbett Avenue, Portland, 97201, 226-2848

Nut Growers Society of Oregon

The purpose of this organization is educational.

1. To keep members informed on the latest technology in producing, harvesting, and marketing of tree nuts in Oregon and Washington.
2. To sponsor a summer tour of orchards, ranches, and farms demonstrating the latest equipment and know how.

As a member of the Northwest Horticultural Congress, it assists sponsoring the annual Northwest Agricultural Show and publishes proceedings, including talks and papers presented at the annual meetings.

Representative: Robert J. Groshong, Route 2, Box 112, Albany, 97321, 928-3676

Oregon Association of Conservation Districts

The 11-district association promotes conservation and wise use of Oregon's natural resources. The association works with other organizations with similar goals to inform the public of the value of soil and water programs in maintaining water quality, prevention of erosion and siltation damages, flood prevention, land use planning, recreation development, and fish and wildlife enhancement.

Representative: Stanley R. Christensen, Route 1, Box 264, McMinnville, 97128, 472-6307

Oregon Association of Nurserymen

Individuals, partnerships, or corporations in the wholesale and/or retail nursery business are members of the association. The purpose of the association is to promote the general welfare of its members, including promoting a greater use of nursery products.

Representative: Verl Holden, Route 2, Box 180, Silverton, 97381, 873-5940

Oregon Broiler Grower Association

The objectives of this association are the advancement, protection, and development of the common interests of those raising Oregon-grown broilers and the promotion of friendly relations within the industry.

Representative: Bill Pastor, 16568 Babler Road, Oregon City, 97045, 631-2308

Oregon Cattlemen's Association

The association represents both the producer and feeder on a regional and national level through the American National Cattlemen's Association both by financial and individual participation. Members participate in and help finance the national livestock tax committee and are active in state and federal legislation. They also work to improve rancher-sportsman relations, support research, fight beef imports, and support public lands and farm labor programs.

Representative: Ermie Davis, Haines, 97863, 856-3486

Oregon Dairy Industries

Members are dairy processors, cooperative and independent, from Oregon and Washington. They promote the dairy products interest of Oregon, arranging programs to help members and sponsoring an annual dairy products contest.

Representative: Lyle Hammack, Raven Creamery, 3303 NE Union, Portland, 97212, 288-5101

Oregon Dairymen's Association, Inc.

Goals are based on the motto "Cooperation for Mutual Profit." Top priorities to make dairying more profitable for dairymen are continued work on legislation and research and development.

Representative: **Stan Masten, Route 2, Box 799, Klamath Falls, 97601, 884-3940**

Oregon Essential Oil Growers League

Growers and buyers of peppermint, spearmint, and dill conduct education and research programs to improve their industry and to inform the public about their products.

Representative: **Bob Houts, Route 2, Box 1656, Madras, 97741, 475-2009**

Oregon Farm Bureau Federation

Members of this organization, which is local, statewide, national, and international in scope, are farm and ranch families. They united to analyze their problems and plan how to improve education, economic opportunity, and social advancement, thereby promoting the national welfare.

Representative: **Waldron Johnson, Route 2, Yamhill 97148, 662-3526**

Oregon Feed, Seed, and Suppliers Association

Members are individuals, firms, corporations, and associations in the feed, seed and allied industries. Objective of the association are to further legitimate interest of the feed, seed, and allied supplies of Oregon while maintaining the highest standards of quality and service and fostering cooperation between the industries and their customers.

Representative: **Ed Enger, Zimmerman Grain Company, Yamhill, 97148, 662-3522**

Oregon Hay Growers Association

Members are any person, firm, partnership, corporation, or association producing or dealing in hay products. Testing of new varieties, support of all phases of forage research, a uniform protein-testing program, and development of overseas markets are among the objectives of the five-district statewide organization.

Representative: **Claude Williams, Route 1, Box 1190, Prineville, 97754, 447-6661**

Oregon Horsemen's Association

The association is devoted to promoting and protecting the interests of the horse industry in Oregon. Representatives work on legislation affecting horsemen and promote horse camps, trail riding facilities, and forest parks. They also help with horse shows and sponsor a yearly short course on horsemanship at Oregon State University.

Representatives: **Larry Spielman, Box 257, Coburg, 97401, 345-0121 (Extension 191) or 687-9123**

Oregon Horticultural Society

Purpose of the society is educational, keeping members informed about technology in producing, harvesting, and marketing of small fruits, tree fruits, and vegetable crops. Representatives participate in legislative activities affecting the horticultural industry. The society helps sponsor the Northwest Agricultural Show.

Representative: **Robert Detering, Route 1, Box 179, Harrisburg, 97496, 995-6418**

Oregon Milk Producers, Inc.

The purpose of the Oregon Milk Producers: public relations. Representatives attend milk hearings and are involved with legislation to get the best possible returns for grade A milk producers.

Representative: **C. A. Chapman, 16408 South Hattan Road, Oregon City, 97045, 631-2182**

Oregon Potato Growers Association

The association supports research and educational programs to benefit the potato grower and seed potato producer in Oregon.

Representative: **Fred Cholick, Route 1, Box 238, Portland, 97213, 621-3528**

Oregon Poultry Industries Association

The objective of the association: To improve the quality of Oregon's poultry breeding stock, hatching eggs, chicks, and meat birds and to work for the general profit of Oregon's poultry industry.

Representative: **Melvin Jenks, Tangent, 97389, 926-8965**

Oregon Seed Growers League

The League seeks to further the interest of the seed industry in Oregon through educational meetings and support of research and legislation that affect the industry. Membership is open to any person, partnership, firm, corporation, or cooperative organization directly and constructively interested in the promotion and advancement of the Oregon seed industry.

Representative: **Don Sandau, 677-78th Avenue, NE, Salem, 97303, 585-1979**

Oregon Seed Trade Association

Active members are individuals, firms, or corporations maintaining an established place of business in Oregon and regularly engaged in the wholesale interstate and/or international distribution of seeds for planting. In promoting the legitimate interest of the seed trade in the state, the association cooperates with educational and regulatory authorities and other agencies in developing an effective seed program.

Representative: James Jenks, Box 215, Lake Oswego, 97034, 362-2478

Oregon Sheep Growers Association

Membership in the association is open to all sheep growers in Oregon. Purpose of the association is to support programs that will help the sheep industry.

Representative: Phil Farrell, Gateway Star Route, Box 490, Madras 97741, 475-2825

Oregon State Beekeepers Association

The association has two purposes: To unite Oregon's beekeepers in their efforts to secure better beekeeping conditions and to develop a strong bond of friendship and fellowship among members of the craft. Membership is open to all interested in bee culture or any phase of the beekeeping industry.

Representative: LaVern Boylan, Route 1, Box 333, Hermiston, 97838, 567-3209

Oregon State Fur Breeders Association

An organization of mink ranchers dedicated to the production and promotion of the mink industry, the association works for improved bargaining conditions and greater strength on a national basis, and disseminates research findings.

Representative: Larry Gardner, Route 1, Box 146A, Sublimity, 97385, 769-6876

Oregon State Grange

Members of this rural-urban family fraternity seek to labor for the good of their non-partisan order, country, and mankind and endorse the motto "In essentials, unity; in non-essentials, liberty; in all things, charity."

Representative: George Jenkins, 873 West 17th, Coquille, 97423, 396-4517

Oregon Turkey Improvement Association

Open to all Oregon turkey growers, the association carries on an educational program for growers and allied industries, promotes the sale and consumption of turkeys, and works to improve breeding stock and control the spread of diseases.

Representative: Earl Stoller, Route 2, Box 121, Aurora, 97002, 678-5403

Oregon Wheat Growers League, Inc.

The basic goals of the league are to promote the interests of Oregon wheat growers by advancing the science of wheat growing, developing markets, improving farm and marketing practices, and conserving natural resources.

Representative: Tad Miller, Route 2, Heppner, 97836, 989-8460

Oregon Wildlife Federation

The Federation consists of member clubs (sportsmen, rod and gun enthusiasts, conservationists, nature lovers, garden clubs, field trial associations, archers, and similar groups) and individuals "who recognize basic individual responsibility in the wise use and proper management of Oregon's natural resources." Its general purpose: To be an effective vehicle for members to study and discuss resource programs, problems, and issues and act on specific proposals and measures designed to preserve and enhance desirable features of the environment.

Representative: Bert Oar, Box 263, Idleyd Route, Roseburg, 97470, 672-5183

Pacific Bulb Growers Association

Members are lily growers in Oregon and northern California. Most of the Association work is done through the Pacific Bulb Growers Research and Development Committee of 12 members.

Representative: Berger Dahlstrom, Harbor, 97415, 469-3542

Portland Wool Trade Association

The Association was set up about 25 years ago when wool dealers negotiated directly with growers. Since the wool business has changed to pool offerings and sealed bids, the Association is down to three members who are keeping the Association alive for future use.

Representative: Harold G. Russell, Pacific Coast Cascara Bark Company, 520 NW 23rd Avenue, Portland, 97210, 228-2404

Sheep Advisory Council

Members of the council are three representatives each of the Oregon Sheep Growers Association, the Oregon Purebred Sheep Breeders Association, and the Western Oregon Livestock Association. Purpose of the council is to discuss programs and projects of sheep research at Oregon State University and to help plan events such as Sheep Day with OSU.

Representative: Wayne Mosher, Douglas County Extension office, Old Nazarene Church, Roseburg, 97470, 672-4461

Southwest Oregon Cranberry Association

Members are cranberry growers in the Bandon area who collectively work on problems of producing cranberries, including obtaining the services of a cranberry consultant for the research program.

Representative: William (Bud) Loshbaugh, Box 857, Bandon, 97411, 347-3726

The Oregon-Washington Farmers Union

Membership is open to residents of the two states who are at least 16 years old and who derive an appreciable portion of their income from producing agricultural, horticultural, livestock, poultry, or forestry products or who work for the Union or one of its subsidiaries. The Union is a part of the Farmers Educational and Cooperative Union of America, and includes local and county unions.

Representative: R. J. Elkins, Willamette Building, Suite 35, 215 Front St., NE, Salem, 97301, 363-6107

Western Oregon Livestock Association

The objective of the association is to safeguard the interests—legislative, promotion, and information—of livestock producers in Western Oregon. It also maintains a close working relationship with Oregon State University Extension and research activities.

Representative: Norman Rydell, Star Route 38, Box 49, Drain, 97435, 584-2246

Winegrowers Council of Oregon

Members are a group of professional Oregon table winegrowers and winemakers who are planting noble wine grapes in all suitable parts of Oregon, bringing to fruition the special Oregon promise of world-famous high-quality table wines.

Representative: Charles Coury, Route 1, Box 255, Forest Grove, 97116, 357-4346

Figure 3c

AGRICULTURAL ADVISORY COUNCIL TO THE PENNSYLVANIA STATE UNIVERSITY

OFFICERS:

President -- Henry R. Geisinger
Vice President -- S. Howard Davis
Secretary-Treasurer -- Galen E. Dreibelbis
Immediate Past President -- John L. Walker
Executive Secretary -- Jack MacMillan

DIRECTORS:

Clyde S. Robison	(Term ends October 31, 1980)
James C. Brown	(Term ends October 31, 1980)
Charles E. Wismer, Jr.	(Term ends October 31, 1980)
John Reed Rodgers	(Term ends October 31, 1981)
James A. Beaver	(Term ends October 31, 1981)
Francis M. Alexander	(Term ends October 31, 1981)
Kenneth G. Beachley	(Term ends October 31, 1982)
George B. Wolff	(Term ends October 31, 1982)
Charles H. Mohn	(Term ends October 31, 1982)

MEMBERSHIP LIST

AGWAY, INC.

Mr. Enos B. Heisey
Agway, Inc.
P. O. Box 4933
Syracuse, NY 13221
315/477-6561

AMERICAN MUSHROOM INSTITUTE

Mr. Charles J. Ciarrocchi
Modern Mushroom Farms, Inc.
P. O. Box 655
Kennett Square, PA 19348
215/268-3535

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS--PENNSYLVANIA SECTION

Mr. Roland Gehman
MGS, Inc.
R. D. #3
Denver, PA 17517
215/267-7528

ATLANTIC BREEDERS COOPERATIVE

Mr. Lee D. Kummer
R. D. #2
Evans City, PA 16033
412/538-4864

COLLEGE OF AGRICULTURE ALUMNI ASSN.

Mr. Michael A. Balas
R. D. #2 Box 2690
Grantville, PA 17028
717/354-1275

DAIRYLEA COOPERATIVE, INC.

Mr. Duane W. Hartzell
R. D. #4
Slippery Rock, PA 16057
412/794-8240

EASTERN MILK PRODUCERS COOPERATIVE ASSOCIATION, INC.

Mr. Clyde Wilson
Rushville, PA 18839
717/934-2302

FARM EQUIPMENT MANUFACTURERS ASSOCIATION OF PENNSYLVANIA

Mr. D. L. Buffington
78 Springers Lane
New Cumberland, PA 17070
717/774-0255

FOREST RESOURCES COMMITTEE-- PENNSYLVANIA CHAMBER OF COMMERCE

Mr. Clarence H. Smalley
Penntech Papers, Inc.
100 Center Street
Johnsonburg, PA 15845
814/965-2521

INTER-STATE MILK PRODUCERS COOP.

Mr. Robert B. McSparran
R. 2
Peach Bottom, PA 17563
717/548-2618

LEHI VALLEY COOPERATIVE

Mr. John C. York
629 N. Derr Drive -- Hunt Building
Lewisburg, PA 17837
717/524-0377

MILK MARKETING, INC.

Mr. John L. Walker
112 Global Building
150 W. Beau Street
Washington, PA 15301
412/228-5350

NORTHEAST DAIRY COOP. FEDERATION, INC.

Mr. James Beaver
817 East Bishop Street
Bellefonte, PA 16823
814/355-2733

PENNAG INDUSTRIES ASSOCIATION

Mr. Donald W. Parke
P. O. Box 329, 119 E. Main Street
Ephrata, PA 17522
717/733-2238

PENNSYLVANIA ANGUS ASSOCIATION

Mr. Conrad L. Grove
R. D. #1
Downingtown, PA 19335

PENNSYLVANIA ASSOCIATION OF CONSERVATION DISTRICT DIRECTORS

Mr. Amos H. Funk
R. D. #1
Millersville, PA 17551
717/872-8084

PENNSYLVANIA ASSOCIATION OF THE FUTURE FARMERS OF AMERICA

Mr. James C. Fink
State Advisor
Pennsylvania Department of Education
333 Market Street
Harrisburg, PA 17126
717/783-6954

PENNSYLVANIA ASSOCIATION OF MILK DEALERS

Mr. Henry R. Geisinger
100 Walnut Street
Harrisburg, PA 17101
717/238-1738

PENNSYLVANIA CATTLEMEN'S ASSOCIATION

Mr. Galen Dreibelbis
100 North Hills Place
State College, PA 16801
814/238-7402

PENNSYLVANIA CHAPTER, ASSOCIATION OF CONSULTING FORESTERS

Mr. Raymond Miller
807 Pennsylvania Avenue East
Warren, PA 16365
814/723-5801

PENNSYLVANIA CHAROLAIS ASSOCIATION

Mr. David D. Seamans
440 E. Fairmount Avenue
State College, PA 16801
814/238-0511

PENNSYLVANIA CHIRSTMAS TREE GROWERS ASSN.

Mr. Donald R. Craul
P. O. Box 648
Lewisburg, PA 17837
717/524-0791

PENNSYLVANIA COOPERATIVE POTATO GROWERS

Mr. Frank O. Ehrhart
550 North Nixon Road
State College, PA 16801
814/238-3142

PENNSYLVANIA COOPERATIVE SHEEP & WOOL GROWERS

Mr. George Downsbrough
1000 Fillmore Road
State College, PA 16801
814/355-1233

PENNSYLVANIA COOPERATIVE SWINE BREEDERS

Mr. Ronald Trostle
R. D. #2, Box 246
Red Lion, PA 17356
717/757-6062

PENNSYLVANIA CROP IMPROVEMENT ASSN.

Mr. Francis M. Alexander
2160 Fox Hill Road
State College, PA 16801

PENNSYLVANIA DAIRY GOAT ASSOCIATION

Mr. Jacob Fisher
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Manheim, PA 17545
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PENNSYLVANIA DAIRY HERD IMPROVEMENT

Mr. Clyde Robison
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Coal Center, PA 15423
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PENNSYLVANIA DAIRYMEN'S ASSOCIATION

Mr. Clyde S. Robison
R. D. #1
Coal Center, PA 15423
412/239-2652

PENNSYLVANIA EGG MARKETING ASSOCIATION

Mr. E. J. Lawless, Jr.
4210-A Sussex Drive
Harrisburg, PA 17109
717/548-3684

PENNSYLVANIA FARM ELECTRIFICATION COUNCIL

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Pennsylvania Electric Company
1001 Broad Street
Johnstown, PA 15907
814/536-6611

PENNSYLVANIA FARM & POWER EQUIPMENT ASSN.

Mr. Arthur J. Smith
P. O. Box 4401
Harrisburg, PA 17111
717/545-2381

PENNSYLVANIA FARMERS' ASSOCIATION

Mr. Charles H. Mohn
22 Polaris, Briarcrest Gardens
Hershey, PA 17033
717/533-7377

PENNSYLVANIA FLOWER GROWERS ASSOCIATION

Mr. Arnold B. Wagner
Box 346, River Road
Bloomsburg, PA 17815
717/784-2260

PENNSYLVANIA FOOD MERCHANTS ASSOCIATION

Mr. Henry G. Sitko
2426-30 Parade Street
P. O. Box 2029
Erie, PA 16521
814/454-3844

PENNSYLVANIA FOOD PROCESSORS ASSOCIATION

Mr. Rocco V. Pugliese
Executive Director
22 S. Third Street
Harrisburg, PA 17101
717/238-1252

PENNSYLVANIA FORAGE & GRASSLAND COUNCIL

Mr. John R. Rodgers
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Reedsville, PA 17084
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PENNSYLVANIA FORESTRY ASSOCIATION

Mr. Clifford B. Carts
Consulting Forester
Mountain Springs, Box 267
Coudersport, PA 16915
814/274-8834

PENNSYLVANIA FOUNDATION SEED COOP.

Mr. Kenneth G. Beachley
P. O. Box 336
Camp Hill, PA 17011

PENNSYLVANIA GUERNSEY BREEDERS ASSN.

Mr. Lee Yost
2497 Lincoln Highway East
Lancaster, PA 17602
717/299-8955

PENNSYLVANIA HOLSTEIN ASSOCIATION

Mr. Harold Davis
R. D. #2
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Mr. William C. Nichol
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PENNSYLVANIA INLAND FERTILIZER ASSOCIATION

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East Petersburg, PA 17520
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PENNSYLVANIA JERSEY CATTLE CLUB

Mr. Samuel B. Williams
2400 Fulling Mill Road
Middletown, PA 17057
717/939-5921

PENNSYLVANIA LIVESTOCK ASSOCIATION

Mr. William J. Gillespie
Route 2
Mertztown, PA 19539
215/682-6161

PENNSYLVANIA MEAT PACKERS ASSOCIATION

Mr. Ronald Fouche
Palmyra Bologna Company
230 N. College Street
Palmyra, PA 17078
717/838-6336

Mr. Glenn Kean
324 Animal Industries Building
University Park, PA 16802

PENNSYLVANIA MOTOR TRUCK ASSOCIATION

Mr. George B. Wolff
212 Blackstone Building
112 Market Street
Harrisburg, PA 17101
717/232-8754

PENNSYLVANIA NURSERYMEN'S ASSOCIATION

Mr. S. Howard Davis
234 State Street
Harrisburg, PA 17101
717/238-1673

PENNSYLVANIA PLANT FOOD & PROTECTANT EDUCATIONAL SOCIETY, INC.

Mr. James C. Brown
2055 Cornwall Road
Lebanon, PA 17042
717/273-3016

PENNSYLVANIA PORK PRODUCERS COUNCIL

Mr. Mark Nestleroth
R. D. #5, Box 428
Manheim, PA 17545
717/665-6220

PENNSYLVANIA POULTRY FEDERATION

Mr. James Price
Beacon Milling Company, Inc.
P. O. Box 1467
York, PA 17405
717/843-9033

PENNSYLVANIA POULTRY PROCESSORS ASSN.

Mr. E. J. Lawless, Jr.
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PENNSYLVANIA PUREBRED DAIRY CATTLE ASSN.

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2497 Lincoln Highway East
Lancaster, PA 17602
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PENNSYLVANIA RAW MILK PRODUCERS-DISTRIBUTORS ASSOCIATION

Mr. Warren Lentz
R. D. #1, Box 284
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PENNSYLVANIA SECRETARY OF AGRICULTURE

The Honorable Penrose Hallowell
Secretary of Agriculture
Pennsylvania Department of Agriculture
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usually friendly, episode in a continuing sequence of episodes involving these users. In most of these formal interactions, users and Station representatives share many common bonds: interests in their state, their commodities, their alma mater, current agricultural conditions, and many others. These common interests usually create an environment that favors free, open, and constructive discussion. For those who have not participated in such meetings, it is important to realize that freedom and openness of discussion do not mean freedom from criticism or challenge, for those are not unusual elements in such meetings.

Listening Meetings -- Research and Extension

In a few states, Station and Extension administrators hold multi-county meetings to which leaders of the area, including many not directly involved in agriculture, are invited. Some are held once a year. Usually each county Extension office identifies the leaders in its county who should be invited to attend. Meetings are open so that others may attend. During these meetings, current research and Extension programs are discussed along with new programs proposed for legislative funding. Some are organized to represent general information of a broad nature; others are organized to present quite detailed information.

During these same meetings, users are asked to identify their priorities and needs. They are also free to ask questions, raise issues, comment adversely, or to respond in whatever way best indicates their concerns.

Participants at each meeting usually number 15 to 30 people. On a statewide basis, they number anywhere from 300 to 700.

Branch Stations and Outlying Locations

As noted earlier, most State Stations have branches, experimental fields or other units located strategically around the state (in one state, many are owned by groups of farmers and leased to the Station).

It is common for these units to have advisory committees chosen or elected from the counties or areas served by the Branch Station. (See Figure 3a). These advisory committees meet regularly, once or twice a year, with Station scientists to discuss the research program and efforts being undertaken and to identify needs and priorities for future work. Usually these groups are keenly concerned about the scientists' responsiveness in addressing current concerns.

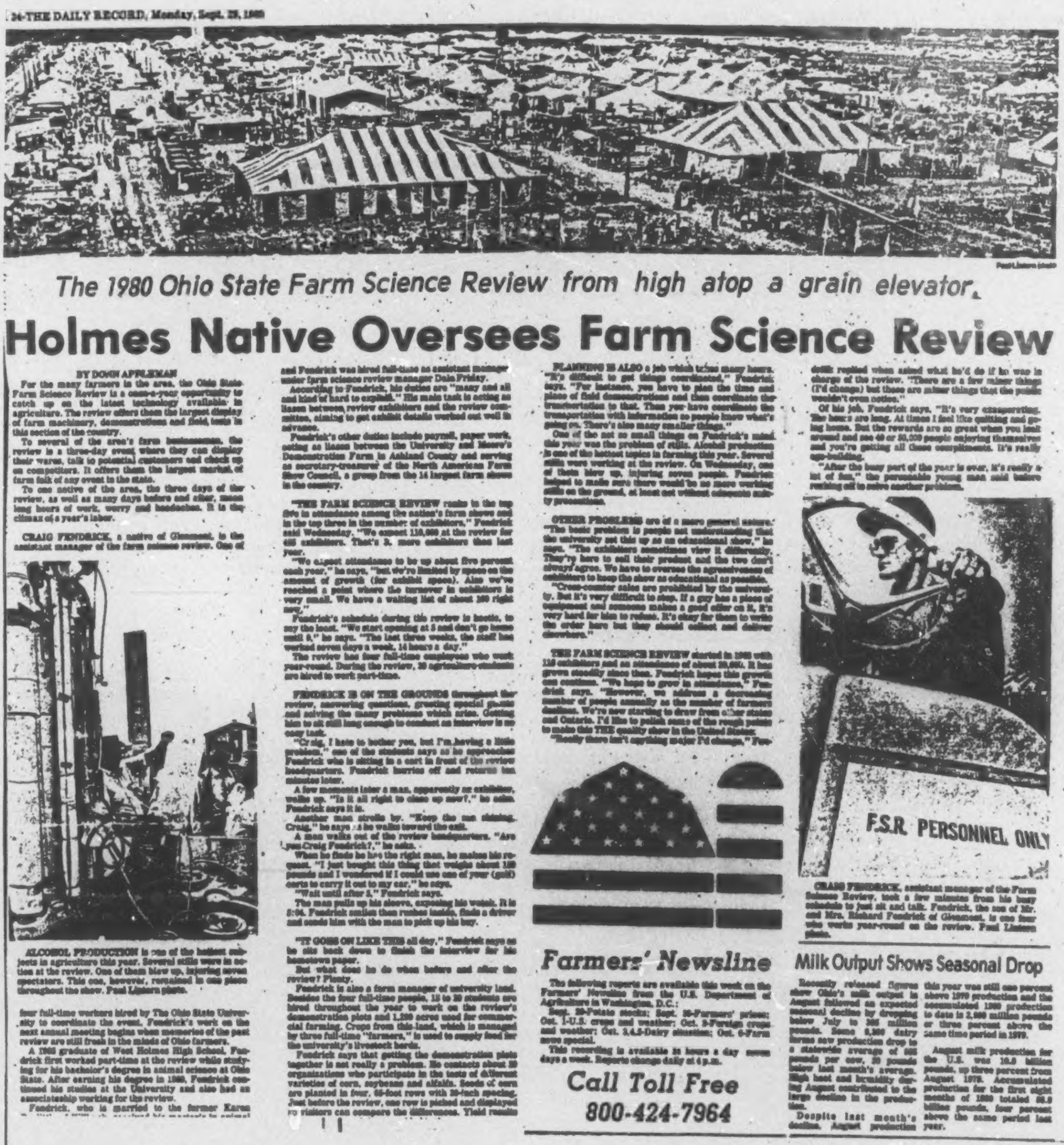
Station Research Days, Open Houses, Field Days

In all states, Station departments and branches regularly hold well-publicized Research Days, Open Houses, and Field Days for the public. Figure 4 presents one example of the many ways in which State Experiment Stations not only transmit research results but also learn from users their needs. During those events, scientists discuss and demonstrate their current research. After each scientist speaks, he responds to questions from the audience. Most questions relate to user needs.

At Field Days, usually scheduled during the spring, summer, and fall, users tour experimental plots and livestock experiments. Research and Extension scientists report discoveries and the latest recommendations. Users normally ask questions of speakers at each stop on the tour. Those questions tell scientists what users' concerns are. Combined attendance at research reporting events at each Station can number in the thousands to tens of thousands of people each year.

Often Station administrators attend Research Days to hear users' questions and responses to reports. Administrators commonly join tour groups to hear what users think and need.

Figure 4. Ohio Farm Science Review presents public and private research and development. More than 110,000 persons attend.



24-THE DAILY RECORD, Monday, Sept. 29, 1980

Paul Lintern photo

The 1980 Ohio State Farm Science Review from high atop a grain elevator.

Holmes Native Oversees Farm Science Review

BY DONN APPLEMAN

For the many farmers in the area, the Ohio State Farm Science Review is a once-a-year opportunity to catch up on the latest technology available in agriculture. The review offers them the largest display of farm machinery, demonstrations and field tests in this section of the country.

To several of the area's farm businessmen, the review is a three-day event where they can display their wares, talk to potential customers and check up on competitors. It offers them the largest market of farm folk of any event in the state.

To one native of the area, the three days of the review, as well as many days before and after, mean long hours of work, worry and headaches. It is the climax of a year's labor.

CRAIG FENDRICK, a native of Glenmont, is the assistant manager of the farm science review. One of four full-time workers hired by The Ohio State University to coordinate the event, Fendrick's work on the next annual meeting begins when memories of the past review are still fresh in the minds of Ohio farmers.

A [illegible] graduate of West Holmes High School, Fendrick first worked part-time at the review while studying for his bachelor's degree in animal science at Ohio State. After earning his degree in [illegible], Fendrick continued his studies at the University and also had an associateship working for the review.

Fendrick, who is married to the former Karen

ALCOHOL PRODUCTION is one of the hottest subjects in agriculture this year. Several stills were in action at the review. One of them blew up, injuring seven spectators. This one, however, remained in one piece throughout the show. Paul Lintern photo.

and Fendrick was hired full-time as assistant manager under farm science review manager Dale Friday.

According to Fendrick, his duties are "many and all and kind of hard to explain." His main task is acting as liason between review exhibitors and the review committee, aiming to get exhibit details worked out well in advance.

Fendrick's other duties include payroll, paper work, acting as liason between the University and Moore's Demonstration Farm in Ashland County and serving as secretary-treasurer of the North American Farm Show Council, a group from the 14 largest farm shows in the country.

"THE FARM SCIENCE REVIEW ranks in the top five in attendance among the nation's farm shows and in the top three in the number of exhibitors," Fendrick said Wednesday. "We expect 110,000 at the review for 435 exhibitors. That's 3 more exhibitors than last year.

"We expect attendance to be up about five percent each year," he says, "but we're limited by space on the amount of growth (for exhibit space). Also we've reached a point where the turnover in exhibitors is very small. We have a waiting list of about 100 right now."

Fendrick's schedule during the review is hectic, to say the least. "We start opening at 5 and don't go home until 9," he says. "The last three weeks, the staff has worked seven days a week, 14 hours a day."

The review has four full-time employees who work year-round. During the review, 20 agriculture students are hired to work part-time.

FENDRICK IS ON THE GROUNDS throughout the review, answering questions, greeting special guests and solving the many problems which arise. Getting him to sit still long enough to conduct an interview is no easy task.

"Craig, I hate to bother you, but I'm having a little problem," one of the students says as he approaches Fendrick who is sitting in a cart in front of the review headquarters. Fendrick hurries off and returns ten minutes later.

A few moments later a man, apparently an exhibitor, walks up. "Is it all right to close up now?," he asks. Fendrick says it is.

Another man strolls by. "Keep the sun shining, Craig," he says as he walks toward the exit.

A man walks out of the review headquarters. "Are you Craig Fendrick?," he asks.

When he finds he has the right man, he makes his request. "I just bought this thing that weighs about 150 pounds and I wondered if I could use one of your (golf) carts to carry it out to my car," he says.

"Wait until after 5," Fendrick says.

The man pulls up his sleeve, exposing his watch. It is 5:04. Fendrick smiles then rushes inside, finds a driver and sends him with the man to pick up his buy.

"IT GOES ON LIKE THIS all day," Fendrick says as he sits back down to finish the interview for his hometown paper.

But what does he do when before and after the review? Plenty.

Fendrick is also a farm manager of university land. Besides the four full-time people, 15 to 20 students are hired throughout the year to work on the review's demonstration plots and 1,200 acres used for commercial farming. Crops from this land, which is managed by three full-time "farmers," is used to supply feed for the university's livestock herds.

Fendrick says that getting the demonstration plots together is not really a problem. He contacts about 20 organizations who participate in the tests of different varieties of corn, soybeans and alfalfa. Seeds of corn are planted in four, 65-foot rows with 30-inch spacing. Just before the review, one row is picked and displayed so visitors can compare the differences. Yield results

PLANNING IS ALSO a job which takes many hours. "It's difficult to get things coordinated," Fendrick says. "For instance, you have to plan the time and place of field demonstrations and then coordinate the transportation to that. Then you have coordinate the transportation with information so people know what's going on. There's also many smaller things."

One of the not so small things on Fendrick's mind this year was the problem of stills. Alcohol production is one of the hottest topics in farming this year. Several stills were working at the review. On Wednesday, one of them blew up, injuring seven people. Fendrick helped to make sure there would be no more working stills on the ground, at least not without adequate safety precautions.

OTHER PROBLEMS are of a more general nature. "The basic problem is people not understanding that the university set this up as an educational show," he says. "The exhibitors sometimes view it differently. They're here to sell their product and the two don't always agree. We have to oversee the aggressiveness of exhibitors to keep the show as educational as possible.

"Cross-counter sales are prohibited by the university. But it's very difficult to stop. If a guy has a piece of equipment and someone makes a good offer on it, it's very hard for him to refuse. It's okay for them to write the order here but they should collect and deliver elsewhere."

THE FARM SCIENCE REVIEW started in 1963 with 115 exhibitors and an attendance of about 20,000. It has grown steadily since then. Fendrick hopes this growth can continue. "We hope to grow in attendance," Fendrick says. "However, we address a decreasing number of people annually as the number of farmers declines. We're now starting to draw from other states and Ontario. I'd like to polish some of the rough points to make this THE quality show in the United States.

"Really there isn't anything major I'd change," Fendrick replied when asked what he'd do if he was in charge of the review. "There are a few minor things (I'd change) but these are minor things that the public wouldn't even notice."

Of his job, Fendrick says, "It's very exasperating. The hours are long. At times I feel like quitting and going home. But the rewards are so great when you look around and see 40 or 50,000 people enjoying themselves and you're getting all these compliments. It's really ego-building.

"After the busy part of the year is over, it's really a lot of fun," the personable young man said before rushing off to solve another problem.

F.S.R. PERSONNEL ONLY

CRAIG FENDRICK, assistant manager of the Farm Science Review, took a few minutes from his busy schedule to just sit and talk. Fendrick, the son of Mr. and Mrs. Richard Fendrick of Glenmont, is one four who works year-round on the review. Paul Lintern photo.

Farmers' Newsline

The following reports are available this week on the Farmers' Newsline from the U.S. Department of Agriculture in Washington, D.C.:

Sept. 29-Potato stocks; Sept. 30-Farmers' prices; Oct. 1-U.S. crops and weather; Oct. 2-Foreign crops and weather; Oct. 3,4,5-Dairy situation; Oct. 6-Farm news special.

This recording is available 24 hours a day seven days a week. Reports change daily at 4 p.m.

Call Toll Free

800-424-7964

Milk Output Shows Seasonal Drop

Recently released figures show Ohio's milk output in August followed an expected seasonal decline by dropping below July to [illegible] million pounds. Some [illegible] dairy farms saw production drop to a statewide average of [illegible] pounds per cow, 30 pounds below last month's average. High heat and humidity during August contributed to the large decline in the production.

Despite last month's decline, August production this year was still one percent above 1979 production and the accumulated 1980 production to date is 2,[illegible] million pounds or three percent above the same time period in 1979.

August milk production for the U.S. was 10.8 billion pounds, up three percent from August 1979. Accumulated production for the first eight months of 1980 totaled [illegible] billion pounds, four percent above the same period last year.

Extension-Derived User Input and Feedback

One of the most important channels through which user needs and priorities are directed to the Experiment Station is the State Cooperative Extension Service. Most of the Extension Service's educational activites are formally organized through county extension councils.

County and area Extension faculty are in daily contact with users, both as individuals and groups, and are readily familiar with the needs and problems of users in their area. Less frequently but nonetheless regularly, Extension Specialists attend or speak at Extension-organized educational meetings or at local meetings of user groups. In those meetings, users freely express their research needs and concerns. Though many needs are specific to that locale and sometimes beyond the resources available to the Station, they still become a part of a continuing flow to research scientists, department heads, and Station administrators. The inclusion of Extension Specialists in the collegiate departments (of research, education, and extension) as well as the involvement of many Extension Specialists in adaptive research in the department has enhanced the transfer among scientists.

Even more important in shaping the nature and priority of research is the Extension Specialist's relative remoteness from the day-to-day activities of the researcher and his proximity to the day-to-day activities of the user. That accessibility to the user's activities enables the Extension Specialist to speak more persuasively from the user's perspective. Extension Specialists with joint research appointments are able to appreciate both interests.

Regional and National Users' Priority Reports

Many of the user groups described in Part II also are organized on a regional or national basis, or both. Many of these regional and national organizations identify priorities, prepare written statements, and transmit these to scientists, departments, and Stations. Among the many organizations that engage in such activities are the Poultry and Egg Institute of America, the National Cattlemen's Association, the National Soybean Growers' Association, the American Soybean Association, and the National Association of Conservation Districts, and many others.

B. Informal Mechanisms

There are numerous occasions on which groups (e.g. the county vegetable growers, the state livestock association, the regional poultry association, the national marketing group) identify a research need of special concern and through a Station department head or administrator arrange a meeting with appropriate scientists. At that meeting, the problem and its possible resolution are discussed. Often individual farmers, leaders, or managers take the initiative to contact the Station about research needs.

Throughout the year, numerous individuals and groups come to see research activities at the Central Station, Branch Stations, and other outlying units. During those visits, these individuals and groups usually identify their needs relating to the research they have seen.

Finally, scientists and administrators of the Station may themselves seek out new ways for expanding economic opportunities of the State by developing new specialty products in response to local interests. Wild rice, guinea fowl, and adzuki beans are examples of specialty products.

C. Priorities Augmented by Special Funding

In recent years, commodity groups and others have furnished funds to support research of special interest to them. "Check-off" funds from sales of soybeans, wheat, beef, turkey, dairy, and other commodities are regularly awarded to Station scientists for research. In these activities, research committees of the commodity groups identify research that is of interest to them, receive small grant proposals from Station scientists, review, the proposals, make awards, and then finally, each year, hear reports of progress.

D. State and Federal Legislative Responses to User Needs

In most states, the State Agricultural Experiment Station budget is a separate line item in the land-grant university budget. Often Branch Stations are budgeted on separate line items, too, because many of them were created by legislative action. Legislative oversight committees occasionally tour Central and Branch Stations to examine the work being conducted. During development of the State budget annually or biennially, hearings are held by committees of the legislature. User groups may testify, at that time, in support of Station priorities or of their needs for other research. Because State legislatures are asked to fund a multitude of new research or educational activities each year by the university or citizen groups, they have become quite selective in their choices. Nonetheless, the legislatures often identify priorities for Station research of their own choosing or in response to citizen appeal.

In a similar fashion, but at a regional or national level, the Congress must respond to requests. It, too, may identify special priorities as it does routinely through P.L. 89-106.

E. Users' Relationships With USDA Agencies and Other Cooperating Institutions

Most USDA Agency research is directed to "national" priorities with focal points in Washington, D.C. or at regional centers. User relationships seem to be principally through either national organizations or associations or local groups. These contacts seem much less frequent, involve fewer people, are more structured, and are narrower in subject-matter concerns than is the case for the State Stations.

As noted earlier, special federal legislation added new institutional participants in agricultural and forestry research, either through formula appropriations or competitive grants. The strength of the relationships between them and the users they serve likely is directly proportional to the research programs and discoveries they can provide users. In many cases, programs are relatively small and specialized. In the case of forestry schools and veterinary colleges in land-grant universities, relations with users are similar to those of Station departments with programs of comparable size. In the case of grants to other institutions, contacts with users are quite infrequent.

F. Impact on Doers and Administrators of Research

The priorities of user groups and individual users have a significant impact on research scientists and administrators. Priorities are addressed as rapidly as resources permit, though within the usual constraints of scientific feasibility and relative importance to the state. Requests for research aid emerging from crises or from impending disasters such as droughts, hail storms, insect plagues, disease outbreaks, and transportation stoppages normally receive immediate attention. Oftentimes it is the researcher's expertise, not emergency research, that is needed. Aside from these crises, priorities often tend to be short-range for specific information rather than longer-range priorities for extending the knowledge base to meet future needs. Striking a balance between the immediately useful and acceptable and the longer range is one of the most challenging tasks facing doers and managers of research.

In many cases, user priorities are already under and have been under intensive investigation in that Station or in other Stations for several years. Many users do not keep abreast of specific research investigations at the Station or of the relative size of investments in various research priorities. They often are adamant about their priorities until they learn the facts.

CHAPTER IV

PRIORITY SETTING PROCESSES IN THE STATION

For many decades, Station Directors regularly have identified research investigations and developed research programs of high priority in their respective states. Resources have been apportioned to them in accordance with their priorities and needs. Setting priorities in a Station which already has an operational research program composed of high priority investigations usually means a reassessment of the current program in light of changing needs and the emergence of new needs.

In virtually all activities, including priority setting, Stations operate in a collegial mode that differs from the hierarchial mode of their USDA counterparts. Planning, priority setting, budgeting, and program development are functions of line administrators and scientists active in research. They are not functions assigned to special staff scientists as some are in USDA agencies. Scientists and administrators have greatest interest in and are fully occupied with the challenges of their research activities or administrative duties. Each realizes that time is his most precious commodity. Planning and priority setting are viewed as helpful, necessary preludes to program choices and resource allocations, but rarely are to be engaged in beyond their perceived usefulness.

Priority setting occurs at several organizational levels, with principal activities taking place in the departments. Scientists active in research in their disciplinary specialization within departments are best qualified (and oftentimes the only qualified people available) to identify and choose the most suitable opportunities to advance their field to meet user needs. They also know best the resources required to explore each opportunity. For those and other reasons, most research resources of the Station are allocated to departments on a continuing basis. As will be made evident later in this chapter, Station control over these resources is assured in many ways.

Before describing in detail the priority setting at each organization level from simplest (by the scientists) to the most complex (by the Station), it is helpful to state simply and clearly the goal of and steps in priority setting.

The goal of priority setting is to aid in allocating scarce resources to develop and maintain an effective and responsive Station research program. Responsiveness implies flexibility of resource use, which can be preserved in several ways.

The steps in priority setting are: (1) to identify the research investigations and research programs of greatest need and value to the State, Nation, and users; (2) to examine the scientific and practical feasibility of those investigations relative to the resources available or required; (3) to set priorities with due consideration for the needs and feasibility of the research investigations and programs; and (4) to respond by actively taking up those investigations given priority.

Research programs of the Stations must be consistent with the mission of the Stations. This has been restated from the federal perspective most recently in the Hatch Act of 1955 (P.L. 84-352) which consolidated the Hatch Act of 1887 and laws supplementary thereto relating to the appropriation of Federal funds for the support of agricultural experiment stations in the States . . .

> Sec. 2. It is further the policy of the Congress to promote the efficient production, marketing, distribution, and utilization of products of the farm as essential to the health and welfare of our peoples and to promote a sound and prosperous agriculture and rural life as indispensable to the maintenance of maximum employment and national prosperity and security. It is also the intent of Congress to assure agriculture a position in research equal to that of industry, which will aid in maintaining an equitable balance between agriculture and other segments of our economy. It shall be the object and duty of the State agricultural experiment stations through the expenditure of the appropriations hereinafter authorized to conduct original and other researches, investigations, and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the

> United States, including researches basic to the problems of agriculture in its broadest aspects, and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contribution by agriculture to the welfare of the consumer, as may be deemed advisable, having due regard to the varying conditions and needs of the respective States.

In addition to this broadly conceived federal mission statement, some state Stations have developed a mission statement consolidating both state and federal missions into a single mission statement for their state. In recent years, many Stations and departments also have developed statements of goals more specific to state needs than those developed nationally as a part of the National Program for Agricultural Research. Figure 5 demonstrates these approaches for three states: Hawaii, Georgia, and Iowa. (Only the first pages of these statements are included here. The remainder are included in the appendix.)

Throughout this paper, relative economic importance of various research programs to the State has been stressed. Social, political, and environmental importance also should be stressed since they, too, are involved in priority setting. From the standpoint of economic issues in priority setting, it is well to note that a relatively small gain in acre yield of wheat in a state producing 12 million acres of wheat is of far greater importance to the state than doubling the yield of a crop grown only on 10,000 acres: a small gain multiplied millions of times over may be more valuable than a larger gain multiplied only a few times. This principle is one of the major guiding forces in priority setting.

A. Separate Priority Setting for Classes of Resources

Because physical plant resources change much less than program resources, it is not uncommon for priorities for the two to be established separately. In some instances, priorities are set separately for certain classes of resources, for example, equipment. These arise out of opportunities for special funding.

B. Priority Setting by Scientists

Background

Scientists are the principal resource of the Station. Virtually all have research doctorates. Most are specialists in a general science, e.g., plant physiology, within their major agricultural science, e.g., agronomy. Some, however, have their doctorates in a general science, e.g., genetics, with specialization in an agricultural science, e.g., poultry science. As noted earlier, most have agricultural backgrounds and maintain close ties with agriculture. Most are in departments with Extension Specialists who are continually exposed to the users' needs. Most were employed by their department because their disciplinary specialization and related training were needed to solve high priority research problems of the State.

Each scientists usually is capable of undertaking research in his major and minor fields of specialization, and with additional training, in closely related fields. However, since World War II, scientific disciplines have advanced so rapidly and broadly that subdisciplines have proliferated. Now most scientists find it necessary to specialize in a small area or subdiscipline. As they continue their research in that subdiscipline, they steadily gain an expertise that enables them to be among major contributors to the advancement of the subdiscipline. At the same time, of course, they fall behind scientists in other subdiciplines. Usually Stations have only one part-time or full-time scientist specializing in that subdiscipline though one or two others may be in closely related subdisciplines. At the disciplinary level there may be a somewhat larger number.

An Experiment Station researcher always operates under a project system. In some departments and some Stations only a single research investigation is included in a project. In others, several closely related research investigations may be included. In every case, the scientist is required to prepare a written project outline in which he justifies the research on the basis of its importance to the State, lists the problems to be solved (i.e., the objectives), reviews the current state of knowledge, and outlines the procedures, approaches, and resources he plans to use. Project outlines must be reviewed by peers and approved by both the department head and the Station Director before investigations can be initiated. If federal partnership funds are involved, the project also must be approved by SEA's Cooperative Research.

Figure 5a. Hawaii's Mission Statement

Presented to the Council of Presidents June 6, 1980
Honolulu, Hawaii

THE ROLE OF A UNIVERSITY IN SOCIETY AND AN ORGANIZATION TO FILL THE ROLE

N. P. Kefford, Director

Hawaii Institute of Tropical Agriculture and Human Resources
College of Tropical Agriculture and Human Resources
University of Hawaii

I am asked to speak to you about the organization of the College of Tropical Agriculture and Human Resources, University of Hawaii. This means to me that you wish to know about our perception of the functions of the College within both the University and the society we call Hawaii and how we have organized ourselves to carry out these functions optimally.

I believe I can convince you of substantial progress with a concept of organization, management, planning and implementation that has significance not only within the University but throughout the agricultural activities of our community and that also has a potential for use in all State activities. Indeed, I would recommend its use on a mini-scale for attacking the type of issue that the Council of Presidents appears prone to address.

In the broadest sense, we are evolving an organization which will permit us to carry out the full role of a university in society. I am very pleased that the Council of Presidents is studying our University in depth because there has been too little University/community interaction at sufficient depth to permit critical assessments. If today, we are to assess the efforts of my College to assume its role in our community, we must first have a common understanding of the role of a university in a society.

It is said that universities created western society and that the nature of our society could not be sustained in the absence of universities. That statement claims, rather strongly, that a university is an essential sector of society and that it has a role which uniquely sets it apart from other sectors such as the commercial, political, regulatory, religious, civic, military, and so on.

What then is a university's unique role as a distinct sector of society? I propose that a university can be described as that sector of society with

Figure 5b. Georgia's Mission Statement

Toward 1985

A Message from the Director

The primary purpose of the University of Georgia Agricultural Experiment Stations is to seek, verify, publish, and disseminate new knowledge in the fields of study within agriculture, to the benefit of the producers and consumers of the state.

Georgia's agriculture is unique because there are so many alternatives. Few other states have such a wide variety of crops and growing conditions, and few states have such a large potential for further development. This places a heavy responsibility on the state's agricultural experiment stations to make the wisest possible use of our limited resources for agricultural research.

Scientists of the various divisions within the University of Georgia College of Agriculture experiment stations were asked to identify their major research goals for the period 1980-1985, a period that will surely see major adjustments in our way of life and in the ways in which our farmers and businesses will produce, process, and distribute our food and fiber products. We believe that you, the people of Georgia, will be interested in knowing the top research priorities that have been identified by our scientists.

William P. Flatt, Director
University of Georgia College of Agriculture
Experiment Stations

Figure 5 c. Iowa's Mission Statement

LONG-RANGE PLANNING - IOWA
AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION

Introduction

The scientific manpower devoted to agricultural research in the United States today represents the greatest array of talent ever assembled to focus on food-oriented research on any continent of the world. It represents a complex of many competencies and a large investment in farms, laboratories, buildings and equipment. Research embraces a large portion of agriculture's highly trained manpower in the USDA, industry and at the Land-Grant institutions. This is a valuable national asset. These resources are capable of assisting the United States and the world to survive, to develop and to fulfill most human needs to a greater degree. The management of this valuable asset--that is, the organization of it for maximum service--is of local, national and international concern.

The state experiment station is one unit of the large, complex, agricultural research establishment involving Federal agencies and industry as well as the state station. At one time the state experiment station was a small group of closely related, locally oriented researchers generating knowledge directly applicable to Iowa farms and farm industries. It has evolved to a large set of sophisticated scientists organized in strong, independent departments, or specialized laboratories generating contributions to science. The direction given to the members of the station staff has been reduced with scientific specialization, growth, the explosion of knowledge, the increase of large specific federal contracts and the orientation of researchers to national or world-wide professional associations. Such specialization may have brought large and rapid scientific advances and an efficiency to the research process. However, in some instances it has also brought fragmentation, reduced local communication among scientists and a threat of less total Iowa benefits. As in all endeavors, specialization creates a larger potential but requires coordination to obtain the expected gains. Specialization creates an increased need for program evaluation and long range planning.

The station administration is expected by the taxpayers and legislature to guide the research program, promote consistency and insure balanced attention to the really significant problems. Goals provide the direction and basis for guidance and planning the research program. Evaluation compares research alternatives as to relative contribution to each goal. Planning formulates the future program from the evaluated alternatives in such a way that the total program has the highest value or pay-off possible.

Prompted by the Land-Grant Conference, held in Colorado in 1963, planning for research in the "Century Ahead" has been the topic of many research administration meetings and speeches. Numerous administrators have taken stock of the past and critically looked to needs and opportunities in their state. Programs of research for the future are being formulated each day. Methods of managing agricultural research in the United States are not well-developed, but work on improving evaluation and management techniques for research is in progress. A comprehensive study of the Iowa College of Agriculture by a local committee was presented to the faculty of Agriculture at Iowa in January, 1965. This in-depth study of the organization, role and programs of agriculture at Iowa State University called for program planning at the experiment station. In 1965, a long-

Figure 5 c., cont.

Range Study of Agricultural Research was requested by the Unites States Senate Committee on Appropriations. The report, developed by a joint committee of USDA-SAES was delivered in September, 1966. The report, while imperfect in some ways, is a major milestone in rational research planning. These studies are evidence of a wide-spread concern for improving the research program in agriculture and related science. The Iowa Station is prompted to undertake an evaluation of prospective research alternatives with respect to state and national goals and to develop a Station plan for 1972.

Projects usually run from three to five years at which time they must be revised or terminated. Scientists must prepare an annual report of their accomplishments and are expected to share it with users. In some states, they also are required to explain the importance of their discoveries to users. Scientists are expected to publish their results in technical and other journals where the scientific and agricultural quality of the work is assessed by peers. At about four or five year intervals, the scientists' progress is reviewed by an external review team. This review focuses not only on past accomplishments but also on future directions and goals.

Scientists may lead one or two projects and collaborate on several others. Scientists may work alone or with collaborators as seems appropriate to the investigation. Figure 6 illustrates the way in which scientists join together to solve users' problems. Like all scientists, Station scientists are expected to keep abreast of advances in their field. Special opportunities are usually provided by the Station through regional committees, task forces, travel funds, and other activities. Scientists also are expected to keep informed of changes in user needs in their area of expertise and to initiate appropriate responses. As noted earlier, particularly in the agricultural production and protection departments, scientists learn of changing user needs through a number of channels.

An approved project normally is allocated supporting Station funds by the department (or sometimes the Station) to be used as the project leader thinks appropriate. Many receive sufficient funds to hire a full-time research technician or one or two part-time graduate research assistants in addition to funds needed for supplies, equipment, and travel. Some receive so little funds that they can hire research aides only infrequently. In addition to supporting funds, the project is assigned supporting experimental resources (animals, plot lands, computer time) and physical plant resources (laboratories, barns, and others) from a departmental pool.

The principal resources available to a scientist are his time and expertise and the time and expertise of his collaborators. Additional resources may include time of research aides, limited operating funds, and access to the departmental pool of experimental and physical plant resources. Each year prior to the preparation of annual departmental and Station budgets, scientists have an opportunity to request additional resources. Every three to five years, at the time his projects are revised or when a new one is prepared, the scientist has another opportunity to secure additional resources. Through their entrepreneurial skills, some scientists are able to secure grant support from federal or state agencies, private companies, commodity groups, and others. Such support is not usually available to all Station scientists.

Priority Setting

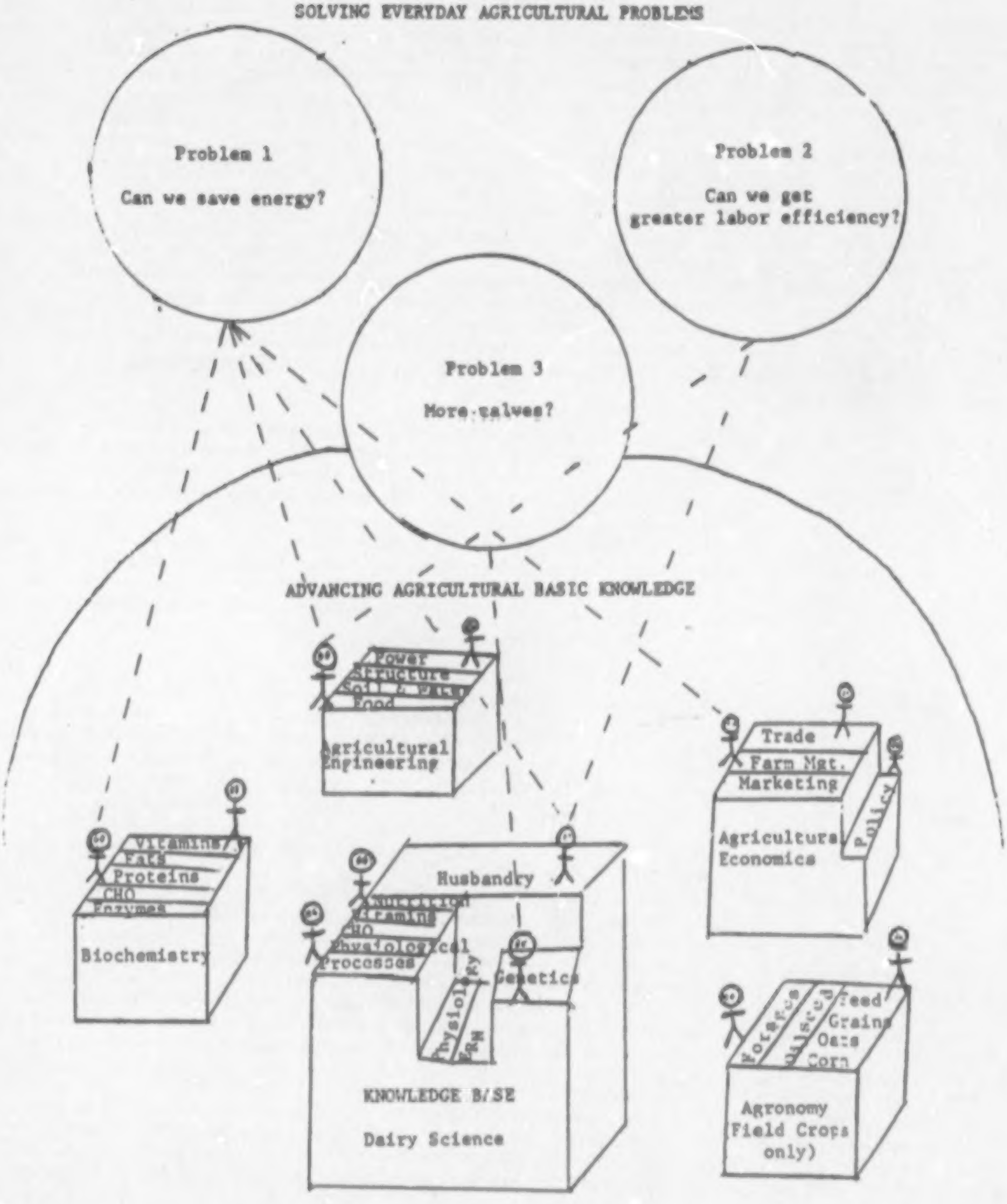
Priority setting is a daily activity of most scientists, much of it occurring in the subconscious. Intermittently, in response to certain demands, it is elevated to the level of the conscious where it can be verbalized and displayed to others. Over time, the daily priority setting forms a sequence of events in which tentative priorities are crudely defined, examined, altered, refined by adding or subtracting issues, and ranked. At intervals, the process is repeated.

The priority setting process follows the general steps outlined earlier in this chapter.

The scientist commences with an examination of user needs which fall into his research or leadership domain. He eliminates those that can be met from existing knowledge or that could be or are being handled by someone in industry or elsewhere. He translates the remainder into approaches he might use in meeting those needs. He examines the relevant current knowledge and pertinent research efforts in the United States. He ponders over the scientific feasibility of his approach and the likelihood of achieving a useful answer. He estimates the time and amount and kind of resources required. He compares the importance (economic, social, or other) of the user needs with those he currently is addressing. He consults with his colleagues and department head about the issues and approaches.

He may decide that he does not have the expertise to tackle those issues. He may decide that the issues are so important that he should suspend what he is doing and start immediately on them. Or, he may decide to take up the issues by gradually shifting some of his time and resources, perhaps by assigning them to a graduate research assistant. He may decide that the

Figure 6. A Diagram Showing How Research Scientists Organize To Meet Users' Needs


SOLVING EVERYDAY AGRICULTURAL PROBLEMS
Problem 1
Can we save energy?
Problem 2
Can we get greater labor efficiency?
Problem 3
More calves?
ADVANCING AGRICULTURAL BASIC KNOWLEDGE
Power
Structure
Soil & Water
Food
Agricultural Engineering
Trade
Farm Mgt.
Marketing
Policy
Agricultural Economics
Vitamins
Fats
Proteins
CHO
Enzymes
Biochemistry
Husbandry
Nutrition
Vitamins
CHO
Physiological Processes
Physiology
FRM
Genetics
KNOWLEDGE BASE
Dairy Science
Forages
Feed Grains
Oats
Corn
Agronomy (Field Crops only)

needs are somewhat more important than the ones he is presently addressing but that he cannot break off his current work until it is at an appropriate stopping place; or, that he has not and cannot get the resources needed; or, that the needs, though interesting, are relatively low priority and should not be addressed.

The scientist also must decide whether grant and contract funds, if any are accessible to him, can help him attain his goals or will cause him to take up lower priority research efforts.

Clearly, the scientist makes many complex value judgments in arriving at priorities. Scientific feasibility is based on the scientist's perceptions of the present state of knowledge relative to the issues, the number, kind, and sequence of discoveries that would have to be made, and the probability of making them. Scientific feasibility requires judgments about hypothetical discoveries. It makes heavy demands on intuition. Even the most gifted, highly-trained mind, conditioned to the specific scientific tasks involved, has no assurance that his intuition will prove even grossly accurate when the judgments emanating from it are subjected to retrospective examination.

C. Priority Setting in the Departments

The departments of the Station bear principal responsibility for meeting user needs that fall within the research or leadership domain of that department's science. As indicated earlier, departments usually have three major functional activities--resident instruction, research, and extension. Priority setting for research must be integrated with that for resident instruction and extension.

The department is best viewed as a group of scientists, a community of equals, whose disciplinary specializations form an array of talent assembled specially to address the functions of the department, i.e., to meet user needs. Each scientist is hired with an understanding of the general responsibilities he is expected to assume for each function. Though these subsequently may be modified or changed, they are altered only with the consent of the scientist.

Priority setting by the department introduces additional considerations not found in the processes of the individual scientist. The central theme of priority setting as being an aid to resource allocation takes on a broader, more complex dimension, for the predictable outcome is for one scientist to be allocated more resources than another. Each scientist, when newly employed, understands and accepts the fact that at that moment there is a differential allocation of resources among scientists. But most scientists optimistically view that as an opportunity, for they themselves may ultimately benefit from that differential allocation. Each is quite familiar with his own research, its importance and needs, and less familiar with others' research. Each also knows the uncertainties of scientific advances in any field. As a consequence, each generally views his research as being of high priority.

Priority setting in research brings together the priorities of the individual scientists, not only for research but also for any other departmental functional responsibilities, including teaching, extension, and international activities.

The priority setting process follows the general steps outlined earlier. But the involvement of the individual scientists in setting the departmental priorities takes on a variety of patterns.

In some departments, all scientists are involved; they reach a consensus about priorities and that consensual list is adopted by the department subject only to moderate, rational alteration by the chairman.

In that collegial priority setting, research scientists hear discussion of the priorities and the rationale for them from individual scientists. Each also makes his own private assessment of that scientist's priorities relative to the scientist's demonstrated ability, his resources, his other commitments, and the group members' personal appraisals of the feasibility of the priorities. Also discussed are pre-existing constraints to priority setting such as: (1) Station or legislative mandates; (2) restrictions placed by a grantor on resource use; (3) differences in kinds and amounts of resources needed and available for each current project; and (4) interruptability or changeability of current investigations. Each participant is influenced by his perceptions of the directions various disciplines of his science are taking nationally.

An alternate collegial pattern is one in which the final setting of priorities is done by the department chairman when a consensus begins to emerge in general faculty or research faculty discussions. This is one of the most common patterns.

Another less collegial approach involves discussion between the department head and each individual scientist. The department head, after those individual discussions, establishes the priorities. He may or may not submit the priorities to department faculty for comments or ratification. This is also one of the more common patterns.

Another approach is an authoritarian one. The department head, relying heavily on his understanding of each scientist's current efforts and on priority discussions in faculty meetings, sets the priorities with only limited faculty consultation. This pattern was employed commonly many years ago, but now is used infrequently.

Singular Role of the Department Head

Priority Setting by the Department Head - The department head bears responsibility for insuring that the research program of his department responds to user needs. The research of most departments consists of few enough projects that the department head can develop a cohesive perception of the general form and substance of the department's research program. In a sense, the projects are the research program; in another sense, they are not. Projects may be very narrow or very broad; several projects may deal with various aspects of the same topic; some are basic and some are applied. Scientists may be engaged in exploratory research a bit beyond the boundaries of their project outline. At other times their efforts exclude important issues included in the project outline.

In my interactions with heads of many departments, I sensed that they developed from their appraisal of user needs an "ideal" and prioritized research program to meet those needs. I also sensed that many considered their research projects as a portfolio of research investigations from which they distilled and synthesized an orderly perception of research topics that form a department research program. This often emerges when they discuss departmental programs with user groups or as they write about their programs.

Such a mental picture of the departmental program enables the department head to set research priorities (which ultimately he translates into resource allocation priorities) more responsively and more assuredly. After the department head has prioritized the program needs, he then does the same for his resources. The intellectual efforts of the scientists are his department's principal resources. To meet program needs he may encourage scientists directly or indirectly to abandon certain efforts in favor of others, to add an additional effort, or to aid another scientist in his efforts. He may need to encourage several scientists to form a team within the department or join another team outside the department. He may think that other resources are needed. Some he may transfer from a department pool--plot lands, animals, laboratories, special equipment, operating funds. Some he may transfer from one scientist to another, principally funds allocated to support graduate research assistants, technicians, or postdoctoral scientists.

There are other considerations in setting program priorities. The department chairman must consider research activities supported by others. One is the research of other agencies. USDA scientists may be stationed in his department to undertake specific research investigations. Or USDA scientists may be in nearby units, attached yet physically removed from the department. They may be in units remote from the Central Station. Or, there may be a major USDA research center in a nearby state. Each of these resources may contribute to meeting user needs in the state and may permit alternate use of resources in the department.

Another consideration is the research of private firms. For example, chemical companies develop pesticides, sterilants, drugs; fertilizer companies develop fertilizers; banks develop agricultural economic projections or farm financial management systems; seed companies develop new hybrids and varieties. There are many other examples of research closely related to Experiment Station research.

In some cases, user needs arise in choosing or using commercial products. Firms may not invest in research to provide clearance for specific crops. Location-specific needs may not be addressed. Farmers may be required to choose from among a large number of varieties from several seed companies. Certain of these issues may be resolved by legislative mandate directing that research be undertaken in specific areas. Most are not, and must be resolved in some rational process by the department head. Resolution may arise from his views on the purpose of public research. If public research is truly a public good, the public's interest is best served when that research retains its ability to speed up or influence the nature of any relevant research that will be useful to the state.

Another consideration is the research needs of alternative culture groups, organic farmers, environmentalists, special interest conservation groups, anti-chemical groups, and others. Each group identifies its needs, but each may represent only a modest number of potential users in the state. And often the economic constraints under which the vast majority of users operate are set aside as only minor concerns.

There are many other issues that arise in setting priorities for resource allocation: retention of scientists who receive employment offers elsewhere; replacement of retiring scientists; buttressing efforts of scientists in critical research investigations not moving as rapidly as hoped; acquisition of additional program and physical plant resources.

Department heads often do not specifically state the rationale they use ultimately in resolving the issues. They likely base their decisions on general characteristics of user needs as outlined in Chapter I.

In stations with small staffs relative to the diversity of agriculture in the state, or in small states, department heads already have accepted their inability to respond to the specificity and immediacy and continuity of needs of certain groups of users. They also have given up comprehensiveness. In many cases, they require scientists to devote less time to specialized subdiscipline research and more time to applied research or to enlarging their perception of broader research fields. In some instances, the Extension Specialist must draw heavily on research done in other states, hoping that its applicability is not too remote.

The Department Head as Entrepreneur - The preceding description of the role of the department head in priority-setting is a rather matter-of-fact account of his daily activities. It misses the mark, however, in depicting him as he really is--an entrepreneur. Out in the state if he is an animal scientist, his advice is sought by livestock leaders almost daily. He may be asked to speak at their annual meetings, to judge their beef shows if he is a judge, to meet with the boards of directors of their associations. In the Station, he is a manager, a risk-taker, an organizer, an expediter, a critic, and a loyal supporter of his faculty. He has the interests of the users, the department, the Station, and his science uppermost in his mind, burdened though he is with an ever increasing load of administrative paperwork.

Throughout this paper, I have repeated the almost univeral plea of department heads for additional scientists and support funds and other resources. Their concern is intense. The issue and its effect in priority setting is easily visualized from an example synthesized from experiences in several states. The animal science departments have responsibilities for the fewest number of food species of most agricultural production departments. As a consequence, their staffing needs are simpler to describe.

Balancing Staffing Requirements - This example is built around an animal sciences department in which processing of animal products is no longer included. The department includes undergraduate and graduate instruction, research, extension, and some international responsibilities. It is the only one of its kind in the state.

Agriculture and related industries constitute the state's largest economic sector. Beef cattle, dairy cattle, and swine are of major economic importance. Poultry is a sizeable economic activity though somewhat smaller than the others. Sheep are of moderate economic importance and concentrated in one large area of the State. Pleasure horse owners number 30,000 families.

The beef cattle industry includes commercial cow-calf herds, many purebred herds of four breeds, and a large number of small herds owned by part-time farmers. Western cattle are fed in a large number of family-owned feedlots. Dairy herds, both fluid milk and cheese, are primarily family-owned and each supports one to four families. Many outstanding purebred herds of all five breeds are located in the state. Swine operations include purebred herds, commercial feeder pig producers, and many confinement rearing and finishing operations. The poultry industry is principally composed of laying flocks ranging from family operations to large commercial flocks. Sheep flocks are mainly crossbred commercial flocks though there are a number of purebred herds. These are the producer-users of animal sciences department research. There are other users, too.

The department head thinks he must have the equivalent of 16 scientists working full-time in research to satisfy minimally livestock industry needs. Animal scientists are typically trained in one of four general science specialties: breeding and genetics, physiology (usually reproductive physiology), nutrition, and management. Ordinarily most have had principal research experience with one kind of livestock though some usually have worked with several on their home farms. The production system and economic considerations in each kind of livestock production are so different and the biological processes so complex that scientists are almost forced to specialize on one kind to develop a true expertise. The department head knows he must have all four specialties for each of three major industries: beef, dairy, and swine. For poultry, he needs all four, but thinks he can get by without a geneticist because replacement pullets are produced by private firms. His poultry research facilities are limited. For sheep, he thinks a nutritionist will suffice; the extension sheep specialist was trained as a geneticist. These 16 research scientists will enable the department to respond to producer concerns, except in sheep. He hopes that research from other states will be applicable, but it may not. User needs for immediacy, specificity, comprehensiveness, and accessibility can be reasonably met with the 16 scientists. It is important to remember that at least four scientists are required to provide comprehensiveness for specialized producers of just one kind of livestock. (I think of this minimal array as a "critical array," analagous to a "critical mass.")

The consequences of not having one or more of these specialists are felt both in the state and in the nation. In the state, it generally produces a reaction first among those users largely dependent on that specialty. They are usually the leaders in adopting new practices. Others watch them and follow their successful example. Producers have no expert to give an opinion; no visible research to lead, direct, or reinforce their search for the most productive practices in that specialty. When a crisis arises there is no one to seek a solution. The impetus for change is slowed or lost. Ultimately it is reflected in a slower rate of growth in productivity.

Nationally, the lack of these specialists reduces the breadth and speed of advance in that specialty. Producers have fewer discoveries to use.

Although the 16 scientists will contribute research of both short- and long-range value, the department head thinks that two areas have unusualy promise for breakthrough discoveries in the next 10 years. He wants to build around the faculty strength in physiology of female ovulation and in ruminant nutrition. For the physiology group he needs at least an endocrinologist and a hormone biochemist and would like to have a histopathologist. For the nutrition group he wants a ruminant physiologist, a ruminant microbiologist, and a nutritional chemist. If he had them, his reproductive physiologists and ruminant nutritionists would be able to deal with a broader range of user concerns while at the same time adding more rapidly to the store of knowledge about the biological processes involved in each subject. The interactions among scientists of the team would be on a broader biological basis. Each scientist in the group would contribute to opportunities that exist in his disciplinary specialty, not only to solving the biology of the issue more rapidly, but also to addressing user needs from another perspective. Team efforts would enhance the output of each individual scientist. Thus they must be together, not at separate locations. Each experimental animal could be utilized for a greater number of purposes thereby increasing efficiency of its use. The additional scientists would require additional resources. However, the incremental addition would be much smaller than the base for each scientist. For each of these scientists the department head needs a lab and equipment. For the department, he also need 40 sows, 60 cows, barns, and herdsmen. He thinks the physiology group will attract some support funds from NIH. The nutrition group likely will receive limited funds from several feed manufacturers.

Finally, he wonders about responding to the needs of horse owners. Several of his scientists are providing what guidance they can, but there is no research in the department and only a little in the United States. The horse owners plan to seek research resources for the station at the next session of the state legislature.

A Commodity Group's Needs - At the single commodity level of concern, the principal feature of user-doer relationships--the merging of practical production issues and research discoveries--can be seen. In the departmental example just outlined, the concerns peculiar to each class of livestock essentially separate them into different worlds. The dairy industry needs can serve as a model.

Every dairyman, no matter how he operates, is reminded daily of the enormous uncertainty of his income, despite the fact that he likely is the least vulnerable of the several classes of livestock producers. He, like most agricultural producers, will be heavily in debt and committed to rigid repayment schedules, some short-term, some long-term.

As he views his daily activities, he will see opportunities to expand his income or to reduce its uncertainty. His cows, his fields, his feed supplies, his equipment, his facilities, his pastures and feed crops, his milk prices will all provide examples. His cows differ in their milk production; if they were all like the best cow, he would be better off. Some have mastitis and some failed to conceive as promptly as they should. His corn in one field looks much better than that in another field. He notices that one field did not pollinate as fully as another. His hay yields were not as good as they were last year. He may accept these facts of life but most do not.

From a research perspective, those few sentences describing the dairyman's daily concerns specify for the station department head the kinds of scientists needed, and a few of the approaches possible. That input is multiplied from thousands of producers.

The Responding Scientist - The four scientific specialties--genetics, reproductive physiology, nutrition, management--have separate research productivity characteristics. Nutrition and management research usually can produce some obviously useful results in six months or a year. The language of the general sciences involved--vitamins, minerals, proteins, costs, efficiency, horsepower--is part of the dairyman's science vocabulary. The sciences relate to visible objects such as feedstuffs, leafiness, equipment. The other two specialties are more abstract and research results much slower. Physiology deals with processes inside the cow. But they are like processes inside humans so the dairyman understands them. Breeding is so abstruse, so mathematically-based, that most dairymen must accept the scientist's research interpretation on faith.

Users' and Scientists' Perceptions of Scientists' Goals - One of the interesting differences in perceptions is that of the user as he views the scientists' research efforts and that of the scientist himself as he does the same.

Agricultural scientists, like all mission-oriented scientists, derive their research orientation from user problems. The scientist draws on his specialty and others' to solve those problems. Diagrammatically, that orientation in order of importance is as follows:

Specific User Problem→Agricultural Science Specialty→Research Project

However, in many instances, the user problem is not one that can be solved rapidly and also may be one of a general class of closely related problems. As a consequence, the scientist focuses on the problem's solution as one of a class of problems which may require a sequence of several research projects extending over a 10 to 30 years period. Until that solution is reached, the scientist may leave the impression that his orientation is as follows:

Research Project 1→Research Project 2→Agricultural Science Specialty→General Problem→Specific User Problem

Thus, it is not unusual for users, exposed only intermittently to the progress of a long-term investigation, to think that his specific needs have been forgotten or put aside for some other issue.

Interpretative Summary - In each specialty there are tens to hundreds of research approaches from which the scientist must choose the one or two he has time and talents to adopt. The department head is aware of those differing characteristics of each specialty and of other differences in resources such as in costs, numbers of animals, duration of resource commitments. (1) He understands both strengths and limitations of the Extension Specialists in dealing with these matters. (2) He knows the resources of allied scientists in economics, engineering, and veterinary medicine. (3) He understands the users' preference for results from within the state, results the users can see. (4) He knows that the adoption rate of local research will be faster. (5) He knows also that in order to provide the scientific expertise in those four areas he must pinch his scientists' operating budgets, often causing them to spend too much time in routine research chores that might be done by someone less highly-trained. (6) He knows that each science moves slowly along its many fronts, and he cannot predict which front will yield the greatest benefits.

(7) He knows that his principal source of resources is the state legislature. Unless the users of his department's research and those users of other stations' research explain their needs to the legislature, the legislature will not see as many opportunities in agricultural research.

(8) He knows that each of his scientists will advance along only a few fronts in his specialty and that the speed with which that specialty advances depends on the size and scope of the national effort. (9) He knows, too, how few scientists nationally are employed to research that specialty. (10) He knows how much his users need their results. (11) He knows that his

scientists, while contributing much that can be applied to both his and other states, are also adding to a basic understanding of the biology of the species with which they work--an understanding that will provide new opportunities 10 to 20 years in the future.

(12) He understands the flexibility that a grant system gives in matching changing priorities to user needs because he, too, uses the departmental reserves under his control and other flexible resources for that purpose. But when he moves resources to other high priorities, he knows that the special equipment the scientist purchased and the scientist's special expertise gained in that priority will continue to serve the station. (13) He wonders about the cost and efficiency of a grant program in "agricultural biology" that creates in a new location special expertise and capacity for research that soon will be lost to agriculture when the grant moves. (14) He wonders how slowly that information will reach his scientists and users. (15) He wonders about the loss of synergistic gains from group interaction both in addressing current user needs and in strengthening the science.

As he views his difficulties in maintaining both "critical mass" and "critical array" of scientists interacting daily on problems of concern to one livestock group, he wonders what effect fragmentation or dissipation of this concentration will mean to users.

D. Interdepartmental and Interdisciplinary: A Systems Approach

Again the two major priority forces--user needs and matching scientific resources--provide a basis for perceiving setting of priorities across departments and disciplines. Oftentimes, department heads operate informally or formally in a group or in subgroups to set priorities for such concerns.

Within a department, several scientists may be tackling a user problem or a scientific problem which may require the efforts of several scientists of different disciplines. Sometimes at the request of the department head or station director as a result of user requests or, more often, as a user need perceived by one or more scientists in a department, scientists collectively may tackle a problem, usually after several discussions of its feasibility and importance relative to those of individual scientists.

A similar process is used to create interdepartmental priorities, sometimes at the instigation of the director, but more often at the instigation of department heads. Again the priorities are set on the basis identified earlier.

Long-term interdepartmental and interdisciplinary research efforts involving more than two or three scientists are often difficult to sustain. On the other hand, efforts involving a pair or trio of collaborating scientists seem to evolve naturally and are often self-sustaining for many decades. Several factors may be responsible. Some are associated with the nature of the problem being investigated; others, with interpersonal and interdepartmental relations and goals and with reward systems. Attempts to solve these difficulties through administrative reorganization seem not to be particularly effective.

E. Other State Agencies

Experiment Stations, being quasi-state agencies for research, work closely with state regulatory or planning agencies such as Agriculture, Economic Development, Planning, Environmental Protection, Energy, and others in identifying their research needs as well as other user needs identified by personnel of these agencies. Personnel of state agencies often are graduates of local institutions, including the colleges of agriculture, so a common bond exists from which priorities may emerge easily. In some states, for example Illinois, Experiment Station administrators and state agency heads meet regularly to discuss needs and priorities. Most, however, spring naturally from the close working relationship.

F. Station Conferences and Committees

In most Stations, the historic tradition of annual conferences of Central and Branch Station scientists has been an extremely effective force. Usually held during the winter months, these conferences provide a means for updating Station faculty about reserach progress in various departments and special needs identified by Extension Specialists. They also provide social and psychological motivation for scientists.

In some Stations, the State conference also provides opportunity for planning conferences between Branch Station and Central Station scientists working on the same (related) research problems. In other Stations, often where Station conferences are no longer held, Annual Planning Conferences, notably in Agronomy, Horticulture, Plant Protection, and Animal Sciences, are important priority setting activities.

In addition in some states, Branch Stations and area Extension activities have been consolidated into area Research and Extension Centers. There, and at the state level, priority setting takes place.

G. Priority Setting in the Station

Most general concerns of the department heads are mirrored by the Station and its Director on a many-times broader scale. Instead of the intricacies of specialization among scientists in one department or among a few departments, now they include those of many departments.

The priority setting processes in the Station follow the same general steps outlined earlier. Both the processes and the issues are much more complex in the Station. Moreover, the perspectives of the Station differ in some measure from those of the scientists and departments. But to insure continuing departmental input, many Stations use department heads as an advisory council in Station priority setting processes.

Background: State and National Priorities

The Station's priorities must address not only direct user needs but also those of the state and nation. Generally, the state's needs deviate from direct user needs only in requiring a somewhat greater attention to certain issues, such as environmental quality, related to ongoing programs. Special needs emerge gradually in the state. They reflect the general temper of the people of the state and of the times. As a consequence, they are readily and automatically perceived by scientists in the state. Many national needs, however, are not so easily discerned.

The Congress debates many societal issues that have impact on agricultural research priorities. Subsequent legislation relates only to a select few. Current research efforts in the Station will be appropriate for some but not for others. The Station's flexibility in addressing short-range issues resides in the ability of individual scientists to shift their efforts in their specialty, and the ability to move program support resources among scientists and departments.

Congressional priorities sometimes require, on a continuing basis, the expertise of scientists not already in the Station. In some Stations, the number of faculty positions is limited by action of the state legislature. In some Stations, program support resources, already very lean, are not flexible enough or large enough to permit hiring of an additional scientist. In order for the Station to respond to that priority it must have new funds or wait until a lower priority position is vacated. For these reasons and others, the Station Director must anticipate as best he can congressional priorities that might impact on Station research.

Stations generally have allocated most resources to research to increase food supplies. That research has been directed principally at manipulating the biology of food plants and animals within the constraints imposed by economics and engineering technology. Some research also has been directed to manipulate the constraints.

Stations have allocated only a moderate share of resources to research on the societal consequences of larger food supplies and of technology developed to produce those supplies. In the last 20 years, food supplies have been abundant and cheap. Inequities in the distribution of food supplies within society have been addressed nationally. In the last 10 years, society's priorities have shifted to the short-range consequences of food abundance and the technology that produces the abundance (e.g., environmental concerns, structure of agriculture, defensive research in response to regulations). That has caused the Stations to move resources for research on those issues away from research to increase food supplies. The consequences of abundant food supply and its associated technology have been explored in this period. Now they are better understood, though imperfectly. Efforts to ameliorate undesirable consequences on human health and the environment are underway.

Today there is uncertainty about the abundance and low cost of food continuing for the next 20 years. The rate of growth of agricultural productivity has slowed. International food supplies are once again in question. The nation's important supply of liquid energy is likely to increase in cost. Sales of the nation's food reserves will possibly increase to aid in maintaining the United States balance of payments. Such are the perceptions of a Director as he commences priority setting.

Current Programs Versus an Idealized Program

As noted earlier, the research investigations of each Station are organized on a project basis. These projects constitute what I have chosen to call the Station's Research Portfolio. In 1977, Stations averaged about 246 projects in their Portfolios, but the number of projects ranged from 3 to 617. The large number of projects and the numerous topical interconnections among projects within and among departments, make it extremely difficult for Station administrators to comprehend the nature and scope of the research encompassed in the Station Research Portfolio. Through the CRIS Classification System, the research investigations described in those projects can be coalesced into several different comprehensible programs; each subdividable into smaller elements. One program presents the research in terms of the agricultural commodities, natural and human resources to which it relates; another, in terms of the major classes of user needs to be solved to achieve state and national goals; a third, in terms of the fields of science involved. These I call Station CRIS Programs.

Information contained in the Research Portfolio and the CRIS Programs and that received from department heads, other administrative units, and scientists, enables the Director and his associates in the Station to perceive unitary form, substance, and boundaries of the Station Research Program. (I use "program" here in its general sense, not in the special sense of CRIS.)

The Station Research Program is a conceptual base to be used in setting Station priorities against which the Director may measure the responsiveness of the Station to its mission and to user needs and priorities. From this conceptual base, he will perceive those changes needed to make the Program more nearly an ideal one.

Priority Setting Strategies: Resource Idiosyncracies

Although Stations follow the general steps of all priority setters, the patterns of the Stations differ in many specifics. These are determined principally by: (1) the historic temper of the legislature with respect to research funding; (2) the temper of Congress with respect to research funding; (3) priorities of the university; (4) shifts of resources and new resources needed to effect changes from current programs to a more nearly ideal program; (5) time required for (4); (6) university, state, and federal budgeting patterns and restrictions; (7) availability of grant and contract funds, (8) organizational structure of Station; and (9) the interrelationships among these.

Let me illustrate a few of these as strategic elements in priority setting. If state or federal funding, or both, have been stagnant, the Director will view priority setting within those constraints. If the resource allocation has been declining, he will be concerned with accommodating that decline as he sets priorities. If resources are steadily increasing or could be made to be that way, he will respond in his priority setting in another way.

In many states, priorities of the university take precedence over those of the Station. During the past 20 years, as student enrollments and federal grant research expanded markedly, university priorities for agricultural research often did not match either the expectations of users or of the Stations. In many states, the university priorities could be rearranged only by diligent efforts of users in acquainting the legislature with their wishes. In many states, changes in university priorities took place only after changes in administrators or rearrangements in administrative structure.

University, state, and federal budgeting patterns and restrictions are significant strategical elements. State resources are usually divided into two major classes for priority setting because that is the manner in which they are considered by the state legislature. One class is physical plant resources which include buildings, land, and fixed equipment. The other is program resources which include scientific personnel, support personnel, operating funds, and moveable physical resources including machinery and equipment, research animals and plants (including trees), and in some instances, temporary structures such as sheds. In some states, program resources also may be subdivided into two or more separate priority setting subclasses. Sometimes personnel salary and fringe benefit increases are included as part of the general university budget request to the legislature. Sometimes some major costly equipment and machinery items also are included in a pooled request from the university. Federal partnership resources, on the other hand, are almost exclusively research program resources. Although the federal government has often treated personnel salary and fringe benefit increases for federal employees as a separate budget category, it has not done so for employees supported from federal partnership funds in the Stations. Federal Hatch funds cannot be carried over from one year to the next. As a consequence, physical facilities usually must come from state resources. Hatch funds, on the other hand, permit broader attention to basic research on the biology of food species and to social science research than may be permitted with state funds.

Priority setting for the two classes of resources usually occurs somewhat independently and on a different time scale for each class. Physical plant resources have a much longer priority range than most program resources. Because of their longer range, their "permanence," and their separate treatment by the legislature, physical plant resources often appear only fitfully among priorities which so often are priorities for program resources. The two classes of resources obviously must be meshed in priority setting, though at times they seem to be out of synchrony.

The organizational structure of the Station may be a strategic element. In at least one state, research resources are distributed as a part of the general university budget, not as a part of the State Experiment Station. In some states, the Branch Stations are separate appropriation items, and their resources may rise or fall independently of the Central Station resources. In some states, virtually all Station research is within the college of agriculture. In others, it may be in many colleges.

Because of these variations among states and universities, it is quite difficult to describe priority setting except in general terms. The steps indicated earlier are followed. Priority setting may involve horizons of time, program resources, physical plant resources, personnel resources, faculty resources, experimental resources, state resources, federal resources, and many others.

Summary

The Director and his associates set priorities within the opportunities and constraints peculiar to their state. They seek to maintain and develop a research program responsive to user, state, regional, and national needs. Because they are removed from the daily operations of the departments, they are able to view the Station program from a vantage point that enables them to concentrate on research programs of the departments more or less independently of the personalities involved. From that perspective, they are able to achieve an appropriate balance among the programs of the various departments.

In some cases, they may decide to build on the strengths of certain departments as a part of their responsibility in developing national resources in the agricultural sciences.

In attempts to enhance the effectiveness of their priority setting processes, several Stations have experimented with formal resource allocation models and techniques from time to time.

H. The University Hierarchy

In most states, the Experiment Station as a statewide function is funded as a part of the general university budget but separately from the general instructional budget. In a few states, the Experiment Station budget is separate from the university budget. In at least two states, support of the Experiment Station has been lumped with instructional programs of the college of agriculture and compete with budgets of other colleges for priority.

In most states, the State Agricultural Experiment Station and the Cooperative Extension Service as well are viewed as proven instruments for economic development in the agricultural sector of the states' economy. They also are viewed as meeting successfully many rural needs. Their budgets, compared to those of the university, other state educational institutions, and state agencies are relatively small. For these reasons, budget requests from the two units commonly are viewed favorably by state legislatures.

However, budget requests for the two units do not come as isolated requests to the legislature but as parts of a massive, prioritized and complex general university budget. Legislators characteristically are unwilling to interfere in university matters. Hence, if the two units do not receive unusual priority in the university budget request, they are unlikely to receive unusual treatment by the legislature. In many states, the principal deterrent to expanding funding for the Experiment Station has been within the university itself.

The first priority of most universities is for teaching resources. Research is important but usually viewed in the context of supporting graduate programs rather than in the context of aiding economic development of the state. In this context, research needs do not create so strong a sense of urgency among university administrators as they do among Station administrators.

In many states, allocation of teaching resources both by the legislature and by the university to the colleges is in proportion to undergraduate and graduate instructional loads. In other states, no fixed allocation process has been established, and instructional resources are directed towards those colleges providing the most convincing evidence of need or having, for whatever reason, the greatest priority within the university.

Generally, agricultural colleges, because they have faculty employed as research scientists in the Experiment Station, have been viewed as having greater opportunity and resources than the faculty in many other colleges. That has resulted at times in what appears to agricultural administrators as unusually heavy teaching loads. The issue is quite complex and best left to discussion elsewhere. But at least one significant point can be made. During a period of rapidly expanding enrollments, as had been the case for agricultural colleges during the 1960s and for many during the 1970s, internal allocation of instructional resources did not keep up with enrollment. That impinged on research programs of the Experiment Station.

In many land-grant universities, the general educational programs of the university, including building for those programs, took priority over agriculture. This has often been counterbalanced, however, by legislative rearrangement of priorities so as to protect the state's agriculture.

Two critical areas of concern in the university hierarchy are in joint use of campus facilities (buildings, plot lands, barns, herds, and flocks) and in land for instructional and research purposes. Some joint use can be accommodated without impinging on research functions; others cannot. In the past, the only land available on many university campuses for new instructional or student-related buildings was that of the university farms, usually a part of the Station's experimental fields or sometimes land intended for instructional purposes. Though these lands were usually replaced with greater acreage, the replacement lands were often further from laboratories and research offices, forcing scientists who had to meet teaching schedules to curtail their activities.

I. Special Legislative Priorities

It is common for the state legislature to identify problems of concern to them. In many cases, they supply additional necessary resources; in other cases, none.

J. Relationship with USDA and Other Institutions Cooperating on Federal Initiatives

The priority setting process within a state between USDA SEA-AR research units and those of the State Experiment Station is generally a complementary one. Closeness of relationships and integration of priority setting between the Stations and the USDA SEA-AR research units depends, in large measure, on the proximity of the USDA SEA-AR research units to the Station and the terms of the cooperative agreement approved by both parties.

Smaller SEA-RA units on the university campus are generally integrated into the faculties of the appropriate department. SEA-AR research unit leaders usually discuss their priorities with the departments, and both build their respective programs to meet their needs in a coordinated fashion. SEA-AR area directors usually discuss area priorities, plans, and staffing with Station Directors, too. Units remote from the Central or Branch Station, for the most part, develop programs to meet the SEA-AR priorities, though discussion, particularly in the plant sciences, may occur.

The relationship between the State Stations and other institutions cooperating on federal initiatives is, in large measure, different from state to state.

CHAPTER V

JOINT PLANNING AND PRIORITY SETTING - REGIONAL AND NATIONAL SYSTEMS

A. Historic and Philosophical Background

Since the late 1890s, the State Stations have engaged continuously in planning and priority setting efforts among themselves and with the research agencies of the USDA. The intensity of those efforts has increased and subsided as appropriate to the needs of the time. Just as agriculture is sharply differentiated among and within many states, so it is differentiated and specialized in sections, subregions, and regions of the United States. Differences in climate, soil, rainfall, topography, markets, ethnic considerations, and relative comparative advantages have caused production of certain foods to be concentrated: dairying in the Great Lakes States and near population centers elsewhere; corn, in the Corn Belt; bread wheat, in the Great Plains; citrus, in Florida, the Southwest, and California; winter vegetables for fresh market, in Florida and California; summer vegetables, in a number of states. Along with this commodity differentiation, there is a corresponding differentiation in production, service and supply, processing, transport, and marketing systems. There is also corresponding differentiation in research needs. Differentiation among and within commodities varies from commodity to commodity, from subregion to subregion, and from region to region. Although differentiation and concentration are strong forces, they are not so strong as to prevent the production of many commodities from being dispersed through much or all of the country where they are biologically and economically adapted.

Differentiation, concentration, and dispersion affect planning and priority setting by obliterating all but a small number of clear-cut distinctions between state, regional, and national priorities. Thus, in examining the roles of the Stations and the USDA agencies in research, one cannot, in most cases, easily set boundaries for what research each should or should not have responsibility. If each state food and fiber system were independent of that of every other state, i.e., if each state produced and consumed only what it produced, research responsibilities clearly would be principally and appropriately state responsibilities. But that is not the case. There is a high degree of interdependence among states from production to consumption. Some of it is of a regional nature. If the United States were organized politically on some arbitrary regional basis, many of those interdependencies would become a responsibility of regional governments. Even a regional approach based on a single arbitrary division of states among regions would be forced to deal with interdependencies among neighboring states in adjoining regions in certain agricultural issues.

Of course, there are no regional governments so the responsibility must fall to the nation and the Congress. In a sense, regional issues are the "no-man's land" of agricultural research responsibilities.

The intraregional dependencies and certain interregional dependencies have been addressed by joint action of the states and the nation, with the Congress taking the fiscal initiative as it logically should. Both the Stations and the USDA research agencies are involved.

Moving from regional to national issues, once again it is clear that even with state and regional issues addressed from state and regional perspectives, there are many issues that transcend those levels and must be considered also from a national perspective. Research programs that satisfy state or regional goals may not satisfy national goals. Integration of issues addressed separately or disparately in each region, but of common concern to several regions, is one significant element. Another is to maintain a reasonable equity of opportunity and concern for all citizens irrespective of their state or regional location. A third is redress adverse and often unexpected consequences of federal legislation aimed at redressing still other issues. Fourth are some issues resulting from specific needs of federal agencies. While it is clear that the research related to such issues is a national responsibility, it does not follow that that research need necessarily be performed by a federal agency. In some cases, it is preferable that the research not be performed by a federal agency.

Even when international issues are being considered, one finds that there are state and regional concerns. All this is not to say that there aren't some sorts of agricultural research that are principally the responsibility of either the state or the nation. But what it does say is that most issues are of joint, virtually inseparable concern, and that the Congress has a major responsibility for providing integrative initiatives and for addressing the concerns of all citizens from a regional and a national perspective.

When I examined national research priority topics of several years, I was unable to distinguish most of them from topics studied earlier in one or more states or regions. That suggests that many national priority research items might be viewed as expansion of ongoing research rather than as new initiatives.

B. Resources for Regional and National Priorities

Until 1946, State Stations were restrained in what they might do in addressing regional and national priorities by state fund limitations on travel and by lack of state authorization for such activities. Though the Stations had been addressing subregional, regional, and national priorities in their programs, they had no funding mechanisms for systematically approaching such issues. Principal continuing federal appropriations were directed to strengthening the agricultural research of each state with the view that the aggregate effort would have national benefits. (Occasional federal appropriations had provided opportunity for some interstate cooperative initiatives. The funds were so limited that only a tiny fraction of interstate issues could be addressed.) In 1946, the Research and Marketing Act provided a mechanism through the Regional Research Fund (RRF). That fund even today comprises, on the average, only about four percent of the resources of the Stations. Simultaneously, a small cooperative research fund was established to permit SEA-AR to engage in cooperative work with the states.

In the intervening years, the Stations have evolved in each of the four regions (Northeast, North Central, South, and West) highly effective Regional Research Programs through their regional associations of State Agricultural Experiment Station Directors. In each of these Regional Programs, intraregional, interregional, and national concerns are addressed. Collaboration with USDA agencies is actively sought and encouraged in every regional project, both in setting priorities and in conducting research.

The Research and Marketing Act also provided an interregional research mechanism (IR). That IR mechanism has been used principally in recent years only for research of concern to every state. Most interregional research is addressed through the Regional Research Programs. During the 34 years of its existence, the RRF has been under the administrative guidance of Cooperative Research, Science and Education Administration, USDA. This agency, responsible for administering all federal-state partnership funds, has provided exemplary leadership. Throughout the years, it has held to a philosophy of research organization and management that has insured that agriculture's true needs have been addressed.

Before describing in detail priority setting for Regional Research Programs, it is necessary to introduce a slowly evolving change in the perspective of the Congress with regard to the nature and organization of agricultural research. In 1965, the Congress, ever concerned with the careful use of tax dollars and always faced with requests that far exceed the available funds, requested the USDA and the State Agricultural Experiment Stations to review agricultural research and its long-term needs. That 1966 partnership report, "A National Program of Research for Agriculture," set down nine major goals of agricultural research (Figure 7). It also established a rational, comprehensive, and orderly system for classifying research as it relates to one or more of those goals. Like any other product of human endeavors, it was not perfect, nor is it ever likely to be so--indeed, what human endeavor ever is! Yet, after a decade of use, the goals and the classification system have demonstrated their general and continuing utility. They provide a basis for logically approaching joint planning and priority setting in what surely must be one of the most complex and effective research systems in the world.

In 1972, again under the sponsorship of the USDA and the State Agricultural Experiment Stations and with encouragement from the Congress, a Regional and National Agricultural Research Planning System was initiated as the second major step in a process that may lead ultimately to the development of the first and only coordinated, jointly-sponsored, state-national research program. Figure 8 presents the Regional and National Agricultural Research Planning System.

In 1977, the Congress, through the passage of the Farm Bill of 1977, initiated a third major step. It created a Joint Council on Food and Agricultural Sciences which was to provide a coordinative mechanism not only for research but also for education, both collegiate education and extension education activities of the county-state-federal Cooperative Extension Services. It also created a National Research and Extension Users Advisory Board, paralleling the advisory committees which have been employed so effectively in the states for many decades. In connection with the development of an integrated joint state-national research program, the Farm Bill adds three significant features. First, it provides a direct means of correlating manpower needs of the entire system with the training of scientists. That should bring into focus more clearly than ever before the almost complete dependency of the entire system--federal, state, and private

Figure 7

GOALS OF AGRICULTURAL RESEARCH

I RESOURCE CONSERVATION AND USE

II PROTECTION OF FORESTS, CROPS, AND LIVESTOCK

III EFFICIENT PRODUCTION OF FARM AND FOREST PRODUCTS

IV PRODUCT DEVELOPMENT AND QUALITY

V EFFICIENCY IN THE MARKETING SYSTEM

VI EXPAND EXPORT MARKETS AND ASSIST DEVELOPING COUNTRIES

VII CONSUMER HEALTH, NUTRITION AND WELL-BEING

VIII RAISE LEVEL OF LIVING OF RURAL PEOPLE

IX IMPROVE COMMUNITY SERVICES AND ENVIRONMENT

Figure 8

The Regional and National Agricultural Research Planning System

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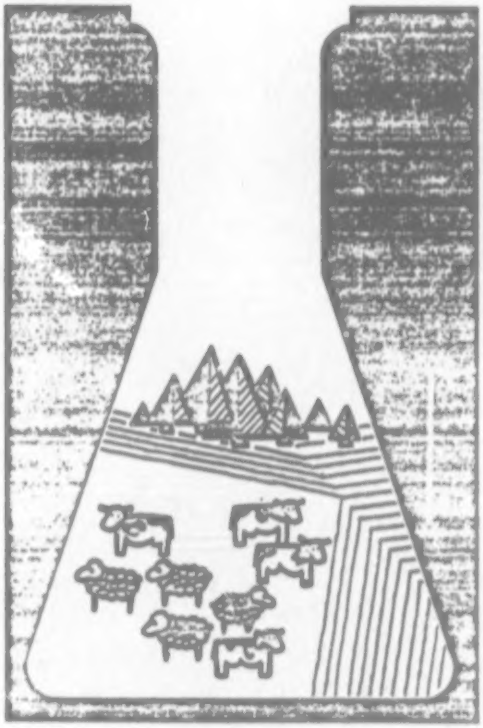
About the System
Who is involved
How it operates
The Payoff



U.S. Department of Agriculture in Cooperation with the National Association of State Universities and Land Grant Colleges

Agricultural Research

Agricultural research is used in the broadest sense to include forestry, other renewable resources, and rural life. It deals with the discovery, combination, and synthesis of knowledge essential to the continuing production and effective use of food, fibre, clothing, and shelter under changing economic, social, and political conditions in the U.S. and the world. It deals with the protection of producers and consumers and with a wise use of natural resources. It involves the elucidation of a broad spectrum of public policy alternatives and consequences.

Many organizations are involved in agricultural and forestry research:

Publicly Supported

- USDA Research Agencies*
- State Experiment Stations*
- Colleges and Universities*
- Other Federal Agencies

*Organizations that together do more than 95% of the nation's publicly supported agricultural research—referred to as the "Publicly Supported Agricultural Research System."

Privately Supported

- Colleges and Universities
- Foundations
- Private Research Organizations
- Corporate Industry

Thus, to ensure the research is being done on the highest priority problems and implemented as rapidly as possible, there is a vital need for coordination of agricultural and forestry research.

The Regional and National Research Planning System

The 1966 report, "National Program of Research for Agriculture," made by scientists and researchers nationwide at the request of the U.S. Senate, specifically recommended a permanent, on-going mechanism for coordinated planning of agricultural and forestry research:

a big job

a challenge

That challenge is being met by a new coordinated regional and national agricultural research planning system. The objectives of the system include:

- more effective use of available scientific talent, laboratories, and other resources in working toward the solution of agricultural and forestry problems.
- identifying emerging problems of national and regional significance and directing resources to the solution of high priority problems.
- increasing the integration of efforts among participants in the system and avoiding unnecessary duplication.

Who is Involved in the Research Planning System

Organizations

The planning system, begun in 1972, is jointly sponsored by the U.S. Department of Agriculture (USDA) and the National Association of State Universities and Land-Grant Colleges (NASULGC) through the *Agricultural Research Policy Advisory Committee*, (ARPAC) (figure 1).

USDA

Agricultural Research Service
Cooperative State Research Service
Economic Research Service
Forest Service

NASULGC

State Agricultural Experiment Stations
Forestry Schools*
Land-Grant Colleges of 1890 and
Tuskegee Institute

Other research organizations, such as the Agricultural Research Institute (ARI), participate, as does the Cooperative Extension Service (CES).

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*Through the Association of State Colleges and University Forestry Research Organizations (ASCUFRO)

Research Leaders

Scientists—Key Participants

Scientists are a major resource in research planning. They have the technical expertise to make important judgments about research possibilities and potential research success. Frequent contracts with research users provided them with considerable judgment about research needs—gaps in knowledge where contigency research is needed, and research priorities. Thus, scientists contribute directly to the efficient management of agricultural and forestry research.

Research Administrators

Research administrators also play key roles in research planning activities. They interact with a broad array of public individuals and groups, including users of research findings, legislators, and with scientists about high priority research problems. They also interact with their fellow research administrators about effective allocation of resources among problem areas across the Nation and within the respective planning regions.

How the Research Planning System Functions

The Structure

National Level

The *National Planning Committee* (NPC) (figure 1) establishes guidelines for national and regional planning operations, reviews planning projections from the various planning units, and develops annual reports contining national and regional programs and program adjustments for successive 5-year cycles. The NPC may charter *special subcommittees* (figure 1) to plan research needs which are national or multiregional in nature. The NPC is composed of administrators of the major USDA research agencies, regional directors of the State agricultural experiment stations, and a representative of ASCUFRO.

Regional Level

There are four *regional planning committees* (RPC's)—Northeastern, North Central, Southern, and Western (figure 1). Although they look to the NPC for guidance on such things as reporting guidelines and for leadership on problems of multiregional and nationwide concern, the RPC's have significant freedom for independent action. The various working groups with the regions are chartered by the RPC's. RPC's include designated USDA regional administrators and directors, state experiment station directors, and representatives of ASCUFRO, ARI, and CES. Where appropriate, representatives of the colleges of 1890 and Tuskegee Institute and schools of home economics are also members.

Each RPC may charter up to seven *research program groups* (RPG's) (figure 1), each dealing with a distinct general subject area, such as "forest resources" or "crops." Research administrators and some scientists, chosen because of a combination of scientific and administrative experience, serve on RPG's. The basic working units of the planning system are the *research programs* (RP's) (figure 1) within the RPG's. They are mostly comprised of scientists organized in groups, frequently called task forces. There may be as many as 47 RP's.

System Operation

The planning operation begins at the research working level.

Regional and Interregional Research Programs (RP's) or Special Subcommittees

Within the regions, the basic working units, the RP task forces plan for individual RP's. This produces integrated research programs which are then submitted to the respective RPG's. Sometimes two or more regions jointly operate an RP task force.

Nationally, and sometimes regionally as well, NPC subcommittees plan for research on specially selected topics that involve all or parts of several RP's in two or more RPG's.

Research Program Groups (RPG's)

RPG's aggregate closely related RP planning projections into single, coherent programs of research. Liaison with other RPG's is established to assure coordination. Research needs and priorities are identified. The RPG's report their findings to the respective RPC's.

Regional Planning Committees (RPC's)

The RPC's develop regional needs and priorities among the seven RPG's and the 47 RP's, based on information received from the RPG's and RP's and other sources—Federal and state research administrators and directors, industry groups, other client groups, and State and Federal legislators.

National Planning Committee (NPC)

The National Planning Committee provides general direction and support to the entire research planning process. It develops national needs and priorities among the seven RPG's and the 47 RP's. It participates in review of planning data and programs and provides feedback to the RPC's.

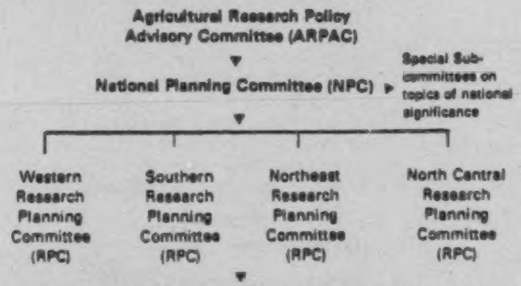
The Agricultural Research Policy Advisory Committee (ARPAC) or the NPC may charter special planning conferences or workshops to deal with significant international or national problems, such as on research to meet U.S. and world food needs or on the development of procedures to be followed in the planning process.

Joint RPC-NPC Operation

Once a year, all research administrators in the publicly supported agricultural research system project program adjustments for the 47 RP's. Projections are made under two assumptions: (1) no increase in resources over the current year, and (2) a 10-percent increase. The "no" increase level emphasizes reallocation of resources to achieve their most efficient and effective use. The "10-percent increase" provides an indication of the administrators' priorities for allocating limited amounts of new resources.

Data are assembled and studied initially by each RPC after which the inputs from the four regions are submitted to NPC for use in developing an overall report projecting and analyzing research program adjustments. This part of the planning system is an iterative process, operating continuously. A new 5-year projection cycle takes place each year. Past and current changes in the allocation of research resources are recorded, and plans for future allocations are made over each 5-year period. Thus, emerging problems are identified and research plans drawn up to achieve rapid problem solution and implementation of results.

Figure 1
The Regional and National Agricultural Research Planning System—Organization and Research Classification.


Agricultural Research Policy Advisory Committee (ARPAC)
National Planning Committee (NPC)
Special Subcommittees on topics of national significance
Western Research Planning Committee (RPC)
Southern Research Planning Committee (RPC)
Northeast Research Planning Committee (RPC)
North Central Research Planning Committee (RPC)

Research Program Groups (RPG) and Research Programs (RP)

RPG 1.00 Natural Resources
  RP 1.01 Soil & land use
    1.02 Water & watersheds
    1.03 Recreation
    1.04 Environmental quality
    1.05 Weather modification
    1.06 Fish and wildlife
    1.07 Remote sensing
RPG 2.00 Forest Resources
  RP 2.01 Inventory
    2.02 Timber management
    2.03 Forest protection
    2.04 Harvesting, processing, marketing
    2.05 Watersheds and pollution
    2.06 Range, fish & wildlife
    2.07 Recreation
    2.08 Alternative uses of land
    2.09 Technical assistance
RPG 3.00 Crops
  RP 3.01 Corn
    3.02 Grain sorghum
    3.03 Wheat
    3.04 Grain
    3.05 Rice
    3.06 Soybeans
    3.07 Peanuts
    3.08 Sugar
    3.09 Forage, range, pasture
RPG 3.00 Crops—Continued
  RP 3.10 Cotton
    3.11 Tobacco
    3.12 New Crops
    3.13 Fruit
    3.14 Vegetable crops
    3.15 Plant enhancement, environment
    3.16 Bees
RPG 4.00 Animals
  RP 4.01 Beef
    4.02 Dairy
    4.03 Poultry
    4.04 Sheep
    4.05 Swine
    4.06 Other animals
    4.07 Aquatic foods
RPG 5.00 People, communities
  RP 5.01 Food & nutrition
    5.02 Food safety
    5.03 Rural development
    5.04 Insects-man
RPG 6.00 Competition and trade
  RP 6.01 Farm price income
    6.02 Foreign agriculture
    6.03 Marketing & competition
RPG 7.00 General Resources
  RP 7.01 General resource technology

The 47 RP's listed above broadly define the scope of agricultural and forestry research with which the planning system is concerned.

The Payoff of the Research Planning System

To the taxpayer-consumer:

greater research output for each dollar and better food, clothing, and housing at reduced real costs. Wiser use of energy and natural resources. A better environment for the future.

To the client groups:

Participation in problem identification and priority setting and planning. An information mechanism through which users of research results in the public and private sectors are kept abreast of research plans and progress. Faster implementation of research results.

To the scientists:

A framework of understanding within which to plan new research and research proposals. A key role in regional and national research planning and policy. Interaction with other scientists.

To the research administrator:

Information that keeps administrators up to date about research needs, priorities, plans and progress in their own organization, as well as other organizations. Allows them to more effectively shift resources and set priorities, better ensuring research on high priority problems.

For further information contact:

Research Planning and Coordination
Room 359-A, Office of the Secretary
U.S. Department of Agriculture
Washington, D.C. 20250

--on the land-grant college Ph.D. programs and they, in turn, on the State Agricultural Experiment Stations for support of graduate M.S. and Ph.D. research assistantships. Second, it should provide a mechanism for testing the impact of proposed or requested federal initiatives and funding levels on the entire state-federal system, rather than as an isolated federal activity or federal-university activity. Third, it should provide the Congress with continuing advice from a small group of users about its views on food and agricultural research needs, a useful check on priorities determined by other groups.

Nowhere else in the federal system has there been an attempt to coordinate state and federal research programs. Perhaps this agricultural effort should serve as a model for other federal agencies.

The evolution of this coordinated research system is not yet complete. The priority setting and planning mechanism developed in response to the Research and Marketing Act of 1946 and those of the Regional and National Agricultural Research Planning System of 1972 are now being consolidated regionally and nationally as experience dictates the appropriate choices. The new mechanisms provided in the 1977 Farm Bill are just now being explored.

Hence, Regional and National Priority Setting is a process in transition. The descriptions that follow represent the situation as it is today. While there are obvious benefits that seem attainable with fuller coordination and integration, there are also costs, dangers, deterrents, and uncertainties. Many stem from our incomplete understanding of the forces that affect creativity, innovativeness, and discovery over long periods of time. Some stem from budgetary and policy considerations.

One must bear in mind that federal appropriations to the Stations constitute only about 16 percent of the average Station's resources. In many major agricultural states, they make up only 10 percent or less of the Station's budget. While Stations cherish the state-federal partnership, they obviously also must look to the interests of their state government which supplies the lion's share of their resources. One also must remember that the research programs of the Stations are broader in scope than those of individual USDA agencies, so broad that they include activities which are responsibilities of several federal departments. These are detailed in Figures 14, 15, and 16. This report deals only with agricultural research, not with forestry nor to any great degree with rural home and community concerns. It focuses principally on the food and fiber system and deals only tangentially with broad social issues emerging from the interaction of the agricultural food and fiber sector with other sectors of the economy. Yet those are priorities in Stations too.

C. Regional Priority Setting

In the late 1940s, the Stations, through their Regional Associations, began to develop regional priority setting mechanisms in order to establish Regional Research Programs supported in part by Regional Research Fund (RRF). In the ensuing 20-year period, each Regional Association developed its own special approach to priority setting within national guidelines established by mutual agreement of the Regional Associations, the Committee of Nine, and the USDA (principally SEA's Cooperative Research). The Stations soon found that they could not develop truly effective Regional Research Programs with only the RRF. Today they invest from other sources 2X to 4X the resources in the RRF. Nevertheless, the Regional Research Program still represents only a modest fraction of the Research Program of each Station.

In 1972, the Stations and the USDA agencies adopted the Regional and National Agricultural Research Planning System. That System required the Stations to involve all of their programs and resources, not just the four percent or so provided by the Congress for Regional Research or the 16 percent provided by all congressional appropriations to the Stations. It also required the USDA agencies to involve all their programs and resources, not just that small fraction conducted at or by State Agricultural Experiment Stations. The goals of the Regional and National Agricultural Research Planning System are indicated in Figure 7.

Thus regional priority setting by the Stations is undertaken now for two purposes: (1) to develop Regional Research Programs supported by RRF, and (2) to meet the Stations' commitment to the Regional and National Planning activities. The two purposes can be viewed as requiring independent but mutually reinforcing activities as they are in the North Central Region. Or, they can be viewed as requiring closely related, interconnected and interdependent activities as they are to different degrees in the Northeastern, Southern, and Western Regions.

The Regional and National Planning activities encompass the entire programs of both State Stations and USDA agencies whereas the Regional Research Programs of RRF encompass only a small segment of Station and USDA programs. Thus, the RRF programs and priorities might be expected to evolve out of the Regional and National Planning activities. For that reason, the latter are described first.

Regional Priority Setting Processes: Regional and National Agricultural Planning

Priority setting as a part of the Regional and National Agricultural Research Planning System follows the general pattern described in the publication, "The Regional and National Agricultural Research Planning System" (Figure 8). The Northeastern, Southern, and Western Regions use that pattern with minor modifications. In general, a Regional (Research) Planning Committee of Station, USDA, and private industry administrators appoints groups of scientists (task forces) to review current research in each Research Program Group or Research Program as identified in the CRIS Classification System. Those groups prepare reports identifying priorities and needs. Those are returned to the Regional Planning Committee for its use. Every two years, regional administrators of USDA agencies, State Station Directors, and administrative leaders of other federal initiative institutional programs estimate program changes to be made in their units in the next five years. The individual unit estimates are combined into a regional summary. That regional summary is studied by the Regional Planning Committee, compared with the priorities identified in task force reports, and finally adjusted by the Regional Planning Committee as seems appropriate. The adjusted regional summary is forwarded to the National Research Planning Committee where changes are incorporated into the National summary. Priorities that transcend the CRIS Research Programs or Research Problem Areas also are identified by administrators of participating units. Those include such topics as Energy, Environmental Quality, and others.

At this writing, the Western Region (Figure 9 depicts its planning and priority structure) has been most active in formally documenting and integrating the priorities emerging from the CRIS computerized planning system and those emerging as Special Topics. Regional research initiated under RRF is an outgrowth of this priority process.

The Southern Region has introduced two innovative additions to the general pattern (Figure 10). They have developed "mini-planning committees" that involve administrators of two or more Stations and of USDA units with activities in those states. Those "mini-planning committees" deal with subregional issues of particular concern to the participating units. Another innovation is in the establishment of a Research Users Group (RUG) for the Region (Figure 11). That group provides a ranking of their priorities for research and serves as a sounding board for research plans of the Region.

The Northeastern Region has selected those RP's most pertinent to its regional interests and 10 Task Forces have prepared or are preparing reports. Additional Task Forces are to be created.

The North Central Region abandoned the use of task forces after an initial trial in the early 1970s. Instead it relies on priority setting committees established in connection with the RRF Regional Research Program (Figure 12).

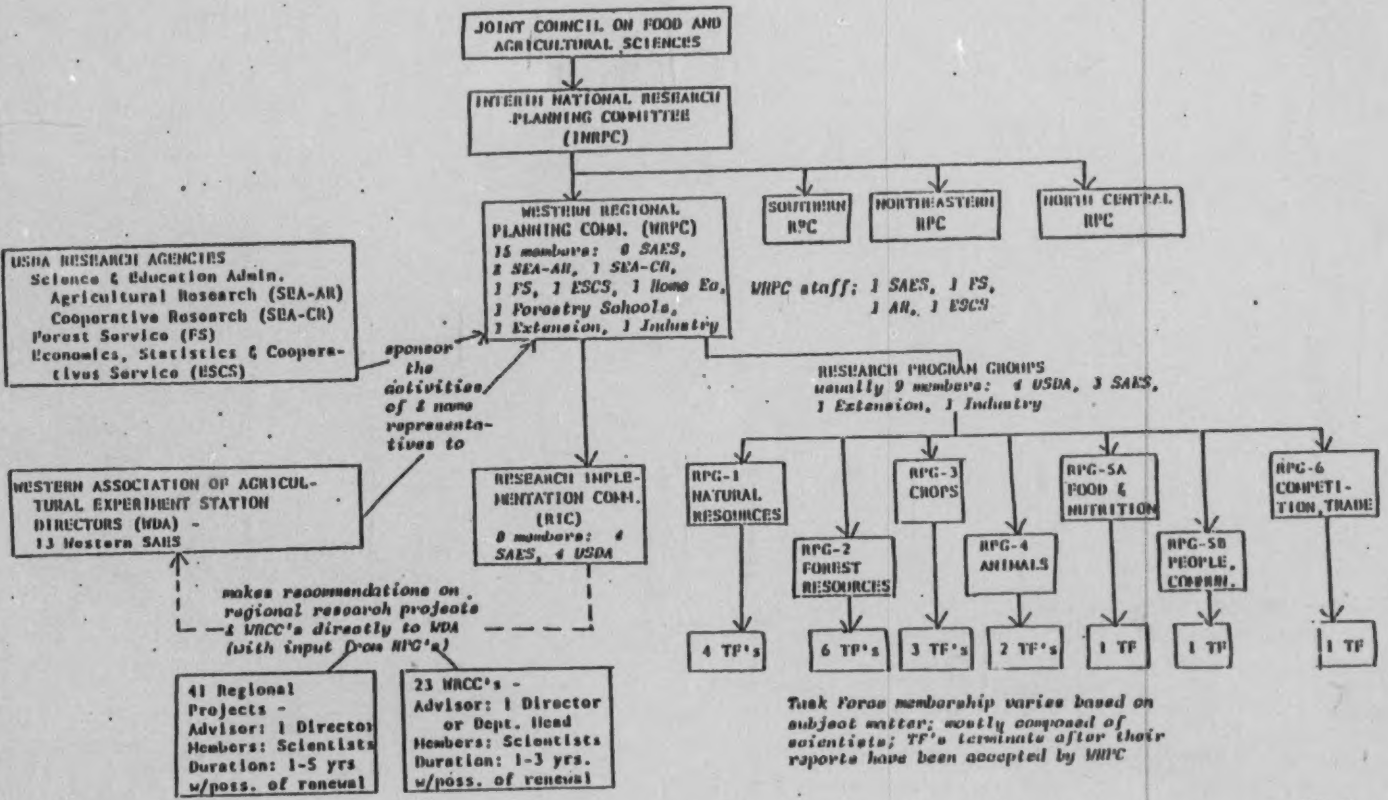
Regional Priority Setting Processes: Regional Research Program (RRF)

Priorities for each Regional Research Program are developed somewhat differently in each region. The Western Region relies on the priorities developed through its Regional Planning Committee (Figure 9). In the Southern (Figure 10) and Northeastern Region, the priorities of the Regional Planning Committees (principally through Task Force Reports) are important aids to committees of the Regional Association of State Experiment Station Directors but the priorities are determined by the Directors. The North Central Region relies on its committee structure developed for that purpose by the Regional Association.

The RRF Regional Research Programs themselves aid in generating priorities through their committees of scientists or administrators. The committees of scientists are of two kinds. One kind manages a regional research project supported by RRF. (I have called these "Regional research projects.") The other kind integrates independent but related research efforts of individual scientists in several states through a regional committee. (I have called these "Regional committees.")

Regional research projects are developed around high priority topics by technical committees composed of interested Station and USDA scientists. Each Regional Project Outline describes the nature of research efforts to be contributed by each participating scientist from each State and USDA unit participating. There are about 197 such Regional Projects in the United States.

Figure 9. Western Region Planning and Priority Structure


JOINT COUNCIL ON FOOD AND AGRICULTURAL SCIENCES
INTERIM NATIONAL RESEARCH PLANNING COMMITTEE (INRPC)
WESTERN REGIONAL PLANNING COMM. (WRPC)
15 members: 6 SAES, 2 SEA-AR, 1 SEA-CR, 1 FS, 1 ESCS, 1 Home Ec, 1 Forestry Schools, 1 Extension, 1 Industry
SOUTHERN RPC
NORTHEASTERN RPC
NORTH CENTRAL RPC
WRPC staff: 1 SAES, 1 FS, 1 AR, 1 ESCS
USDA RESEARCH AGENCIES
Science & Education Admin.
Agricultural Research (SEA-AR)
Cooperative Research (SEA-CR)
Forest Service (FS)
Economics, Statistics & Cooperatives Service (ESCS)
sponsor the activities of & name representatives to
WESTERN ASSOCIATION OF AGRICULTURAL EXPERIMENT STATION DIRECTORS (WDA) -
13 Western SAES
RESEARCH IMPLEMENTATION COMM. (RIC)
8 members: 4 SAES, 4 USDA
makes recommendations on regional research projects & WRCC's directly to WDA (with input from RPG's)
41 Regional Projects -
Advisor: 1 Director
Members: Scientists
Duration: 1-5 yrs w/poss. of renewal
23 WRCC's -
Advisor: 1 Director or Dept. Head
Members: Scientists
Duration: 1-3 yrs. w/poss. of renewal
RESEARCH PROGRAM GROUPS
usually 9 members: 4 USDA, 3 SAES, 1 Extension, 1 Industry
RPG-1 NATURAL RESOURCES
RPG-2 FOREST RESOURCES
RPG-3 CROPS
RPG-4 ANIMALS
RPG-5A FOOD & NUTRITION
RPG-5B PEOPLE, COMMUN.
RPG-6 COMPETITION, TRADE
4 TF's
6 TF's
3 TF's
2 TF's
1 TF
1 TF
1 TF

Task Force membership varies based on subject matter; mostly composed of scientists; TF's terminate after their reports have been accepted by WRPC

JHoak
7/25/79

Figure 10. Southern Region Planning and Priority Structure

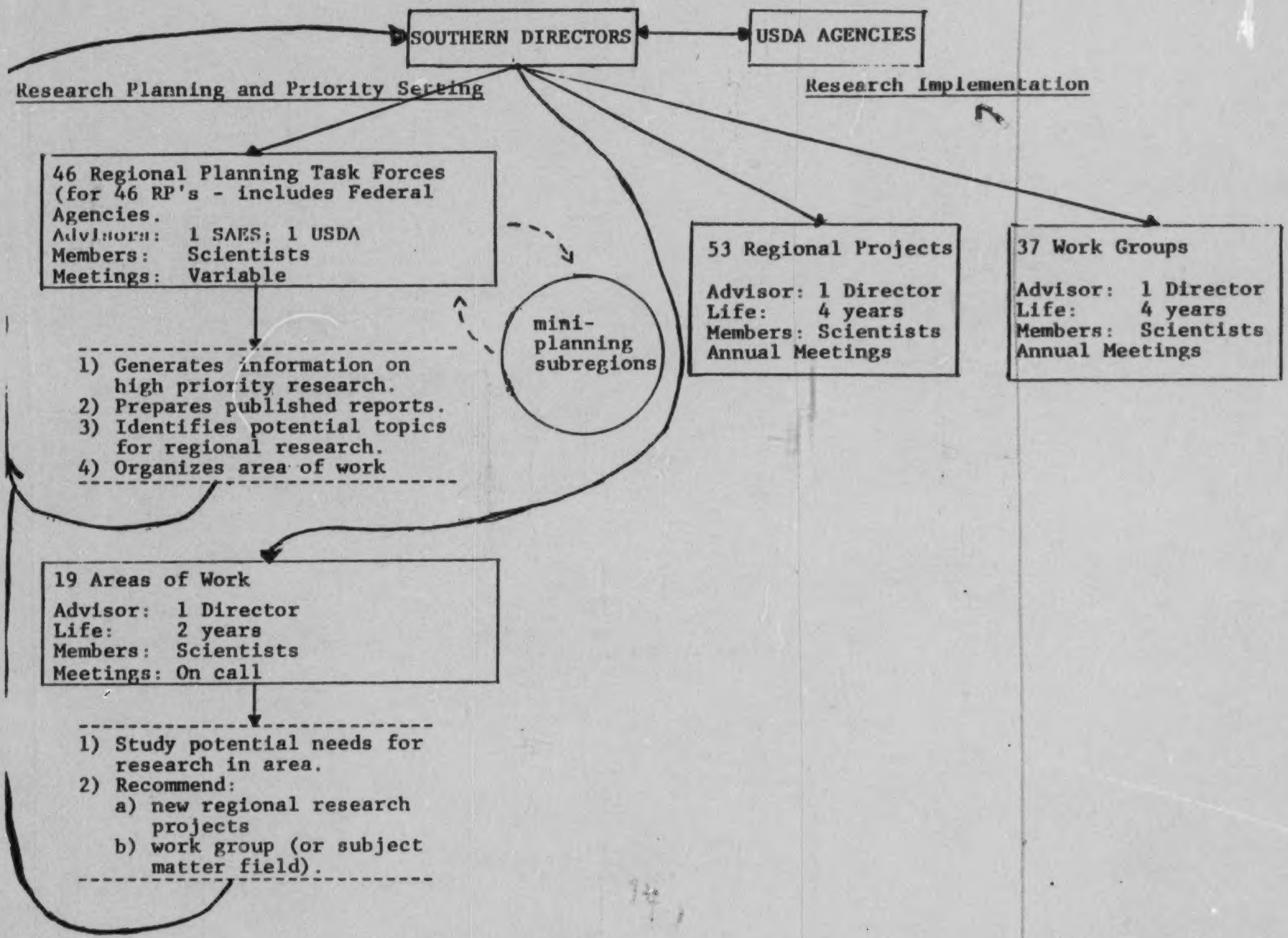
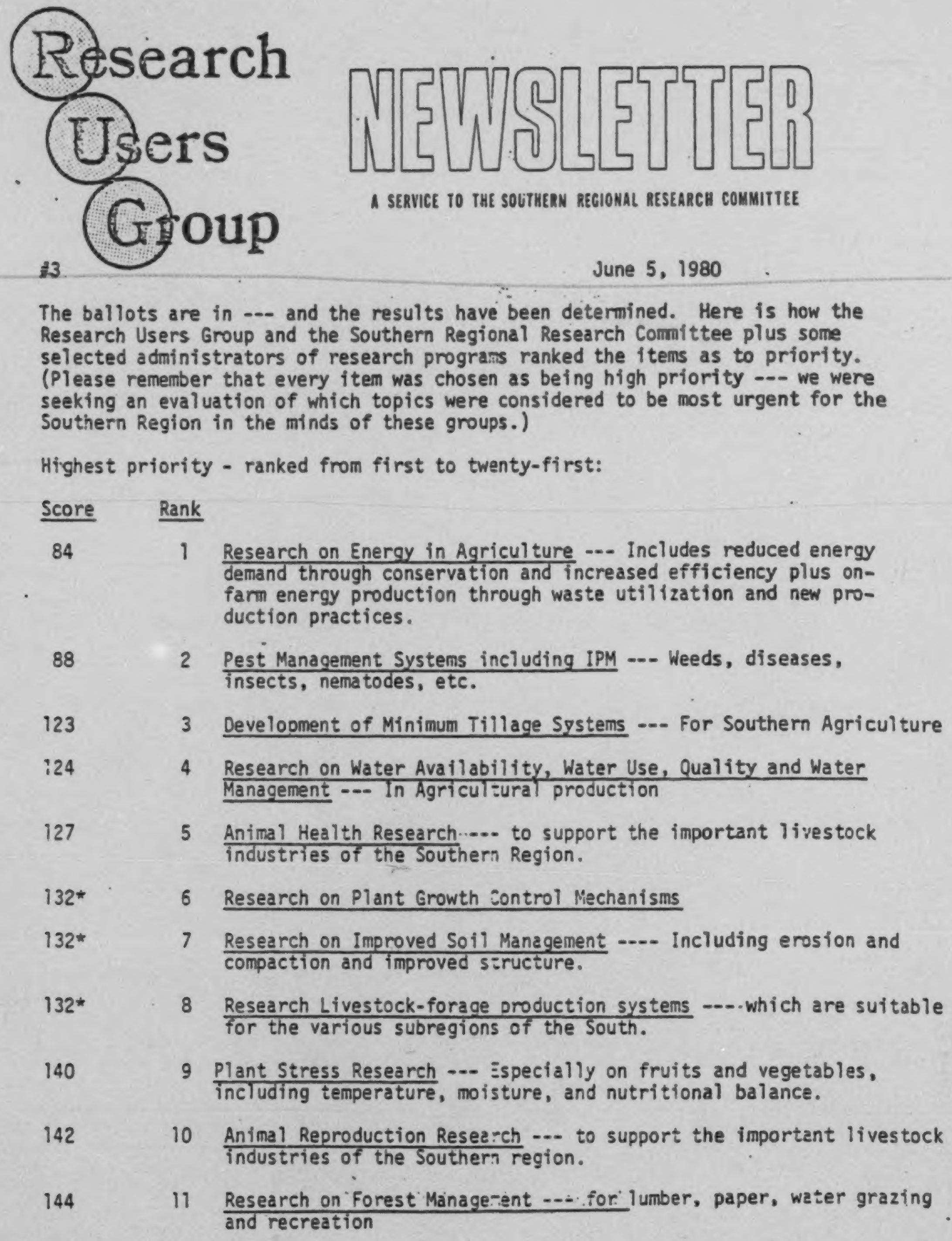

SOUTHERN DIRECTORS
USDA AGENCIES
Research Planning and Priority Setting
Research Implementation
46 Regional Planning Task Forces (for 46 RP's - includes Federal Agencies.
Advisors: 1 SAES; 1 USDA
Members: Scientists
Meetings: Variable
1) Generates information on high priority research.
2) Prepares published reports.
3) Identifies potential topics for regional research.
4) Organizes area of work
mini-planning subregions
53 Regional Projects
Advisor: 1 Director
Life: 4 years
Members: Scientists
Annual Meetings
37 Work Groups
Advisor: 1 Director
Life: 4 years
Members: Scientists
Annual Meetings
19 Areas of Work
Advisor: 1 Director
Life: 2 years
Members: Scientists
Meetings: On call
1) Study potential needs for research in area.
2) Recommend:
a) new regional research projects
b) work group (or subject matter field).

Figure 11.



Research Users Group

NEWSLETTER

A SERVICE TO THE SOUTHERN REGIONAL RESEARCH COMMITTEE

#3 June 5, 1980

The ballots are in --- and the results have been determined. Here is how the Research Users Group and the Southern Regional Research Committee plus some selected administrators of research programs ranked the items as to priority. (Please remember that every item was chosen as being high priority --- we were seeking an evaluation of which topics were considered to be most urgent for the Southern Region in the minds of these groups.)

Highest priority - ranked from first to twenty-first:

Score	Rank	
84	1	Research on Energy in Agriculture --- Includes reduced energy demand through conservation and increased efficiency plus on-farm energy production through waste utilization and new production practices.
88	2	Pest Management Systems including IPM --- Weeds, diseases, insects, nematodes, etc.
123	3	Development of Minimum Tillage Systems --- For Southern Agriculture
124	4	Research on Water Availability, Water Use, Quality and Water Management --- In Agricultural production
127	5	Animal Health Research --- to support the important livestock industries of the Southern Region.
132*	6	Research on Plant Growth Control Mechanisms
132*	7	Research on Improved Soil Management ---- Including erosion and compaction and improved structure.
132*	8	Research Livestock-forage production systems ----which are suitable for the various subregions of the South.
140	9	Plant Stress Research --- Especially on fruits and vegetables, including temperature, moisture, and nutritional balance.
142	10	Animal Reproduction Research --- to support the important livestock industries of the Southern region.
144	11	Research on Forest Management --- for lumber, paper, water grazing and recreation

Score	Rank	
151	12	New Marketing Techniques --- Development and channels for the products of Southern agriculture including problems of transportation and new foreign markets.
152	13	Human and Livestock Nutrition Research
153	14	Development of Germ Plasm collections --- Evaluations and Improvements for new crops
155	15	Research on Transportation Systems --- Costs, Losses and Alternatives
160	16	Research on Losses in the Food System --- Production, storage, preparation and consumption
167	17	Research designed to meet the needs of Small Farmers
170	18	Research to develop Dust Controls --- For mills, gins and elevators
177*	19	Research on Food Safety --- Industrial, Institutional and home
177*	20	Research on Acid rain and other Environmental Contaminants --- To agriculture, forestry and natural resources.
179	21	Research on Improvement of Nutritional Quality --- For production efficiency for agricultural products.

*In the case of ties, the item with the greatest number of one (1) ranks was placed ahead.

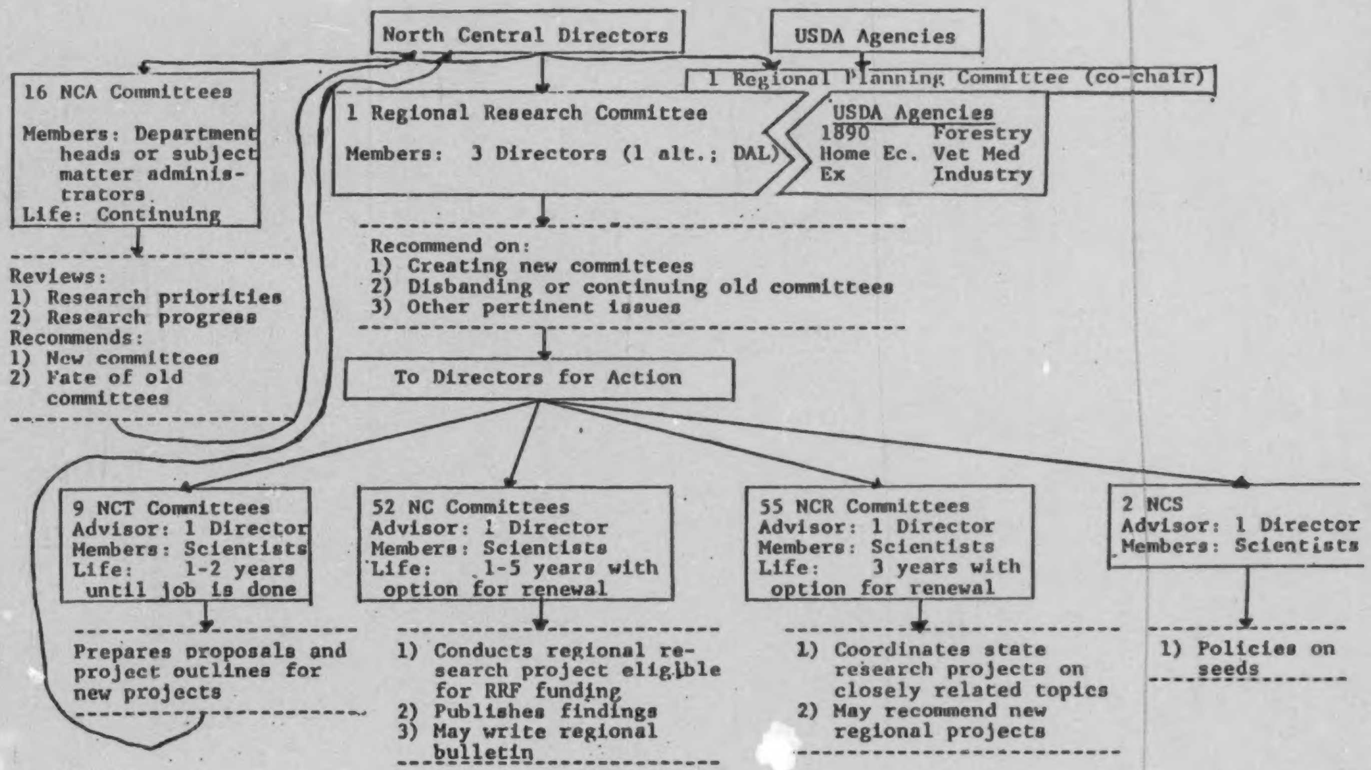
We recognize that these 21 items do not represent all the highest high priority items for consideration. They represent, however, a wide variety of topics which have been highlighted both regionally and nationally. In this ballot, RUG and SRPC have been given the opportunity to indicate the relative importance on these selected topics. Another year, we can develop a new list, expanded to provide greater opportunity for members to include their individual concerns.

We thank you for marking and returning your ballots. In all, 71 ballots were received. SRPC appreciates the interest and support of RUG members.

Thank-you.

James E. Halpin
Editor

Figure 12. North Central Region Planning and Priority Structure


North Central Directors
USDA Agencies
1 Regional Planning Committee (co-chair)
16 NCA Committees
Members: Department heads or subject matter administrators
Life: Continuing
Reviews:
1) Research priorities
2) Research progress
Recommends:
1) New committees
2) Fate of old committees
1 Regional Research Committee
Members: 3 Directors (1 alt.; DAL)
USDA Agencies
1890
Home Ec.
Ex
Forestry
Vet Med
Industry
Recommend on:
1) Creating new committees
2) Disbanding or continuing old committees
3) Other pertinent issues
To Directors for Action
9 NCT Committees
Advisor: 1 Director
Members: Scientists
Life: 1-2 years until job is done
Prepares proposals and project outlines for new projects
52 NC Committees
Advisor: 1 Director
Members: Scientists
Life: 1-5 years with option for renewal
1) Conducts regional research project eligible for RRF funding
2) Publishes findings
3) May write regional bulletin
55 NCR Committees
Advisor: 1 Director
Members: Scientists
Life: 3 years with option for renewal
1) Coordinates state research projects on closely related topics
2) May recommend new regional projects
2 NCS
Advisor: 1 Director
Members: Scientists
1) Policies on seeds

Regional Committees also are developed around other high priority topics. But the purpose of these committees is to integrate current research efforts of Station and USDA scientists into a regional approach and to encourage those scientists to direct their efforts so as to meet both unit (State or USDA) needs and regional needs. There are about 129 such regional committees in the four Regions. In addition, there are 12 more in a special Regional Group, the Great Plains. Priority setting for topics to be covered as Regional Projects or by Regional Committees is the responsibility of the Regional Directors' Associations and the Committee of Nine. Priorities emerge from many sources: as project outlines, or as proposals to create projects or committees. They come from Station Directors of each Region, Regional Project Committees, Regional Committees, Regional Planning Committees and their Regional Task Forces. (In the North Central Region, Advisory Committees composed of department heads replace the Regional Task Forces. In the Western Region, a Research Implementation Committee composed of Station and USDA administrators implements the recommendations of the Regional Planning Committee.) Priorities are discussed by the Regional Research Committee and presented to the Directors' Association. The Directors' Association recommends approval, rejection, or alternatives to the Committee of Nine and to the Secretary of Agriculture.

Nature of Priorities - Regional Project priorities are priorities that require the efforts of at least two or more Stations. Most represent combined efforts of seven to eight Stations. They address four major categories of issues: (1) emerging regional and national issues, (2) issues that require long-term efforts of many states, (3) regional issues too large or costly to be accomplished by a single state, but which may be led by a single state, (4) issues that require immediate solution and in which sizeable inputs from several states are required.

Recent emerging regional and national issues include energy; environmental quality and policy, including acid rain; exports and transportation, food system control; rural employment, population distribution and governance; rural development; and climate. Examples of long-term efforts include improving plants and animals through breeding and crop and livestock production systems. Examples of issues too large or costly to be accomplished by a single state include maintenance of plant germ plasm resources, cattle breeding, protecting against pesticides in the food chain. In several cases, a single Station with unique capabilities for leading such regional effort had been identified as a "center of excellence." Regional funds from all states of the region are directed to that state, e.g., center for plant germ plasm, pesticide residues, and rural development. Among the issues that require immediate solutions are disease outbreaks, pest control (gypsy moth, southern pine bark beetle), and effects of toxins and toxic wastes (mycotoxins, heavy metals in sewage sludge).

Issues that emerge as national research priorities usually have been explored as regional priorities long before they receive national attention.

Regional committee priorities focus on two issues: (1) integrating the efforts of individual scientists from many Stations in disciplines of an agricultural science so as to provide for the rational and least costly scientific expansion of that agricultural sciences, and (2) exploring and integrating interdisciplinary efforts that involve several agricultural sciences. In both cases, individual scientists with special disciplinary expertise in one or a few states are able to join with specialists in other states in mutually complementary efforts.

In both regional project and regional committee priorities, arbitrary regional boundaries are set aside by encouraging participation of Stations anywhere in the Nation. In the most recent analysis of regional projects, 110 of 197 projects included scientists from two or more regions (Figure 13). And in 16 projects, all four regions were participating. Thus, regional projects and regional committees, to a lesser extent, are able to address issues of any scale, from regional, interregional, to national. In all regional projects and committees, USDA agency scientists may participate. Usually there is strong USDA representation in many projects. (The multiregionalization of regional projects has reduced the need for and use of the RRF Interregional mechanism, IR.)

D. Regional Priorities: Philosophical Conflicts

State Experiment Stations and USDA Agencies

Each of the four regional associations of the State Agricultural Experiment Station Directors has developed processes for establishing priorities on an intraregional, interregional, and national basis.

Figure 13

Multiregionalization of Regionally Sponsored Projects (SAES Participants Only)

Region Sponsoring Project	Number of Projects Sponsored	Single Region Only	Number of Projects with Multiregionalization			
			No. of Participating Regions			
			2	3	4	Total
NC	53	27	7	10	9	26
NE	50	18	17	12	3	32
S	53	27	17	6	3	26
W	41	15	15	10	1	26
Total	197	87	56	38	16	110

Number of Stations Participating in Regional Projects

Region Sponsoring Project	Number of Projects Sponsored	Number of Projects						
		Number of Participating Stations						
		2-4	5-7	8-10	11-13	14-16	17-19	20+
NC	53	2	7	13	16	11	3	1
NE	50	5	11	22	6	6	0	0
S	53	4	9	24	14	2	0	0
W	41	1	10	16	11	3	0	0
All	197	12	37	75	47	22	3	1

During their regular meetings (usually three each year), the Directors discuss both their individual state programs and regional programs with other Directors. This informal exchange of information and ideas enables the Directors to avoid unnecessary duplication of effort and to participate more effectively in regional priority setting processes. Superficially, these seem different because the organizational trappings carry different names in different regions. But the underlying philosophies are much alike. As noted earlier, priority setting and research program development are not separate activities in the Stations. Although priority setting precedes program development, the two are closely linked and always personally controlled by the Director. This linkage in a single person is a continuing source of difficulty when regional associations attempt to integrate their activities with those of USDA agencies. Although SEA-AR has a recently developed regional structure, regional AR administrators have only minimal control over program development. Priorities they set for their regions may or may not be in the priorities chosen by national administrators.

As noted earlier, the Stations have research responsibilities for a broader range of research topics than the USDA agencies individually and collectively. The commitments of each performing agency to United States agricultural research is detailed by Research Program Groups (Figure 14), Research Programs (Figure 15), and by Research Problem Areas (Figure 16).

At the grossest level of aggregation (by Research Program Groups), allocations of federal and state resources to each group are quite similar in their proportions. However, with each succeeding level of disaggregation, the differences between state and federal allocations become more and more pronounced. When the commitments are displayed by states or regions, the differences are even more striking and variable. Clearly, the priorities of the State Stations and the USDA agencies are not the same. Nor is it possible for the states to rely in any significant measure on federal agencies to meet needs of state users in a balanced way.

Though regional AR administrations act in good faith when they join in planning and priority setting with Stations of their region, their priorities are always understood by both partners in the State-USDA system to be subject to sudden dramatic alteration at the national level. The alterations usually are not perceived as whimsical changes but a product of the political philosophy of the USDA (and of many other federal agencies).

Hubert Humphrey stated the issue plainly. It is the conflict between "tops-down" and "bottoms-up" identification of priorities. The conflict creates a serious dilemma for the Station Directors of each Regional Association.

Each Director has carefully sought out the needs and priorities of users in his state. Each has sought the judgment of his scientists as to the feasibility of addressing those priorities. Each has a perception of the program that is considered appropriate by his state legislature, the principal source of the station's support funds. Each has a perception of the mandates of the federal legislation which provides a small but important fraction of his Station's support funds. Each has some notion of congressional concerns. Each is prepared at the meetings of his Regional Association to discuss and debate regional and national priorities as viewed by other Directors in the region and as developed through orderly mechanisms of the Association. Each is prepared to compromise, to trade, to adjust his priorities in the interest of regional and national concerns. Each is prepared to act then and there. Each understands that a commitment to either regional or national concerns is not just a commitment of the three or four percent of his budget that comes from RRF, but a commitment enlarged three or four times from other resources. Preparedness and resolve to debate and compromise are of limited use when one partner is hindered or prevented from making commitments.

As a consequence, the regional and even the national priority setting process becomes principally a route for improving communication among the Stations and between the Stations and the USDA. And secondarily, the differences in priorities of the two partners cause each to reassess their individual priorities (or group priorities, as is the case for the Regional Directors' Associations). Subsequent readjustments, independent of the other partner, likely provide more effective use of resources. That is the setting in which regional priorities are now established.

Regional Associations of State Experiment Stations

In Chapter IV, I described the "natural" structuring of individual agricultural sciences, the kinds of disciplinary specializations, and the minimal numbers of scientists needed to address user needs. I also commented briefly on the fact that each scientist deals simultaneously with technological or "applied" research and with "basic" research oriented to the long-range needs of agriculture. I also noted that each individual scientist can engaged in only one or a few of the many possible approaches to solving user needs. The arithmetic of the situation is simple.

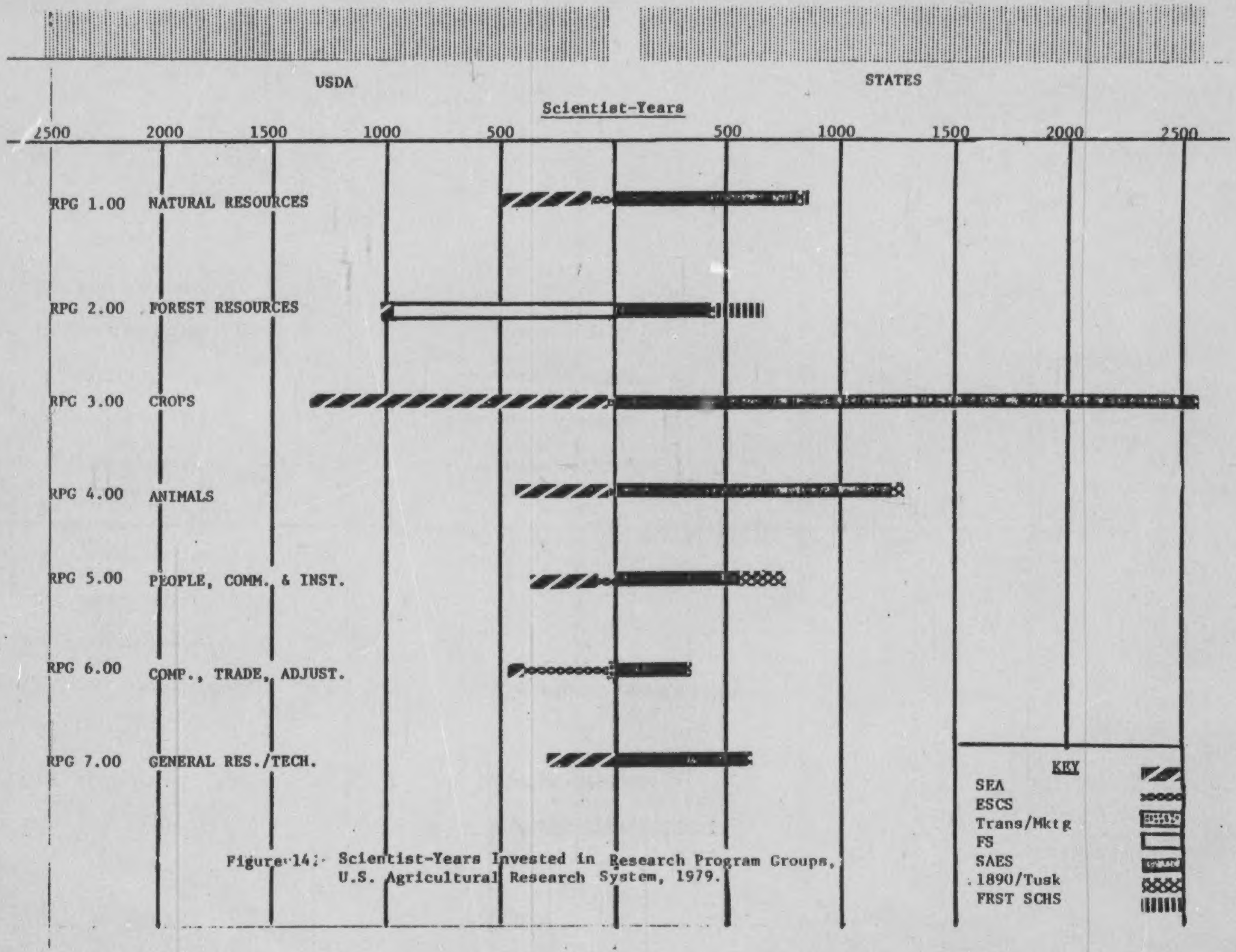


Figure 14: Scientist-Years Invested in Research Program Groups, U.S. Agricultural Research System, 1979.

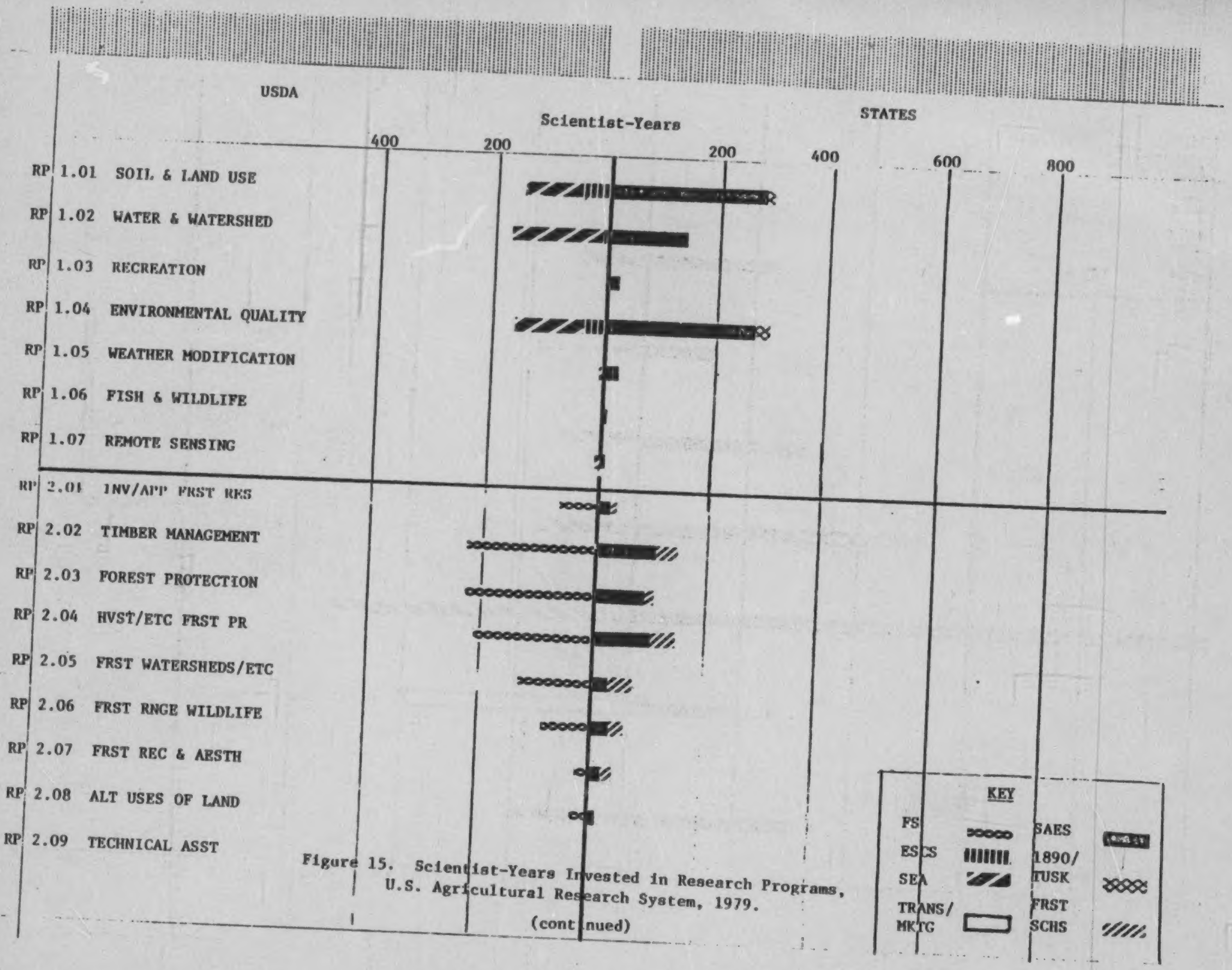


Figure 15. Scientist-Years Invested in Research Programs, U.S. Agricultural Research System, 1979.

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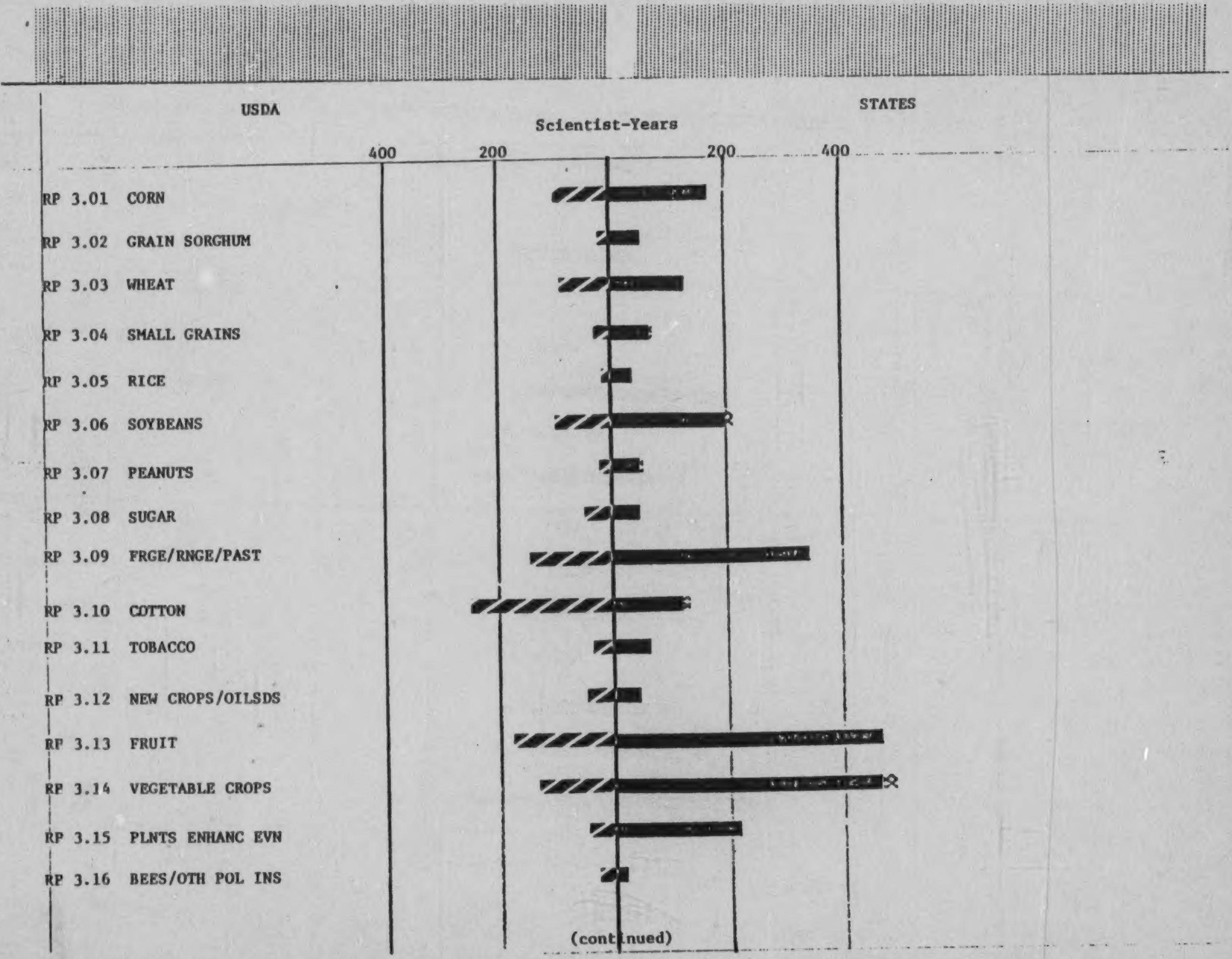
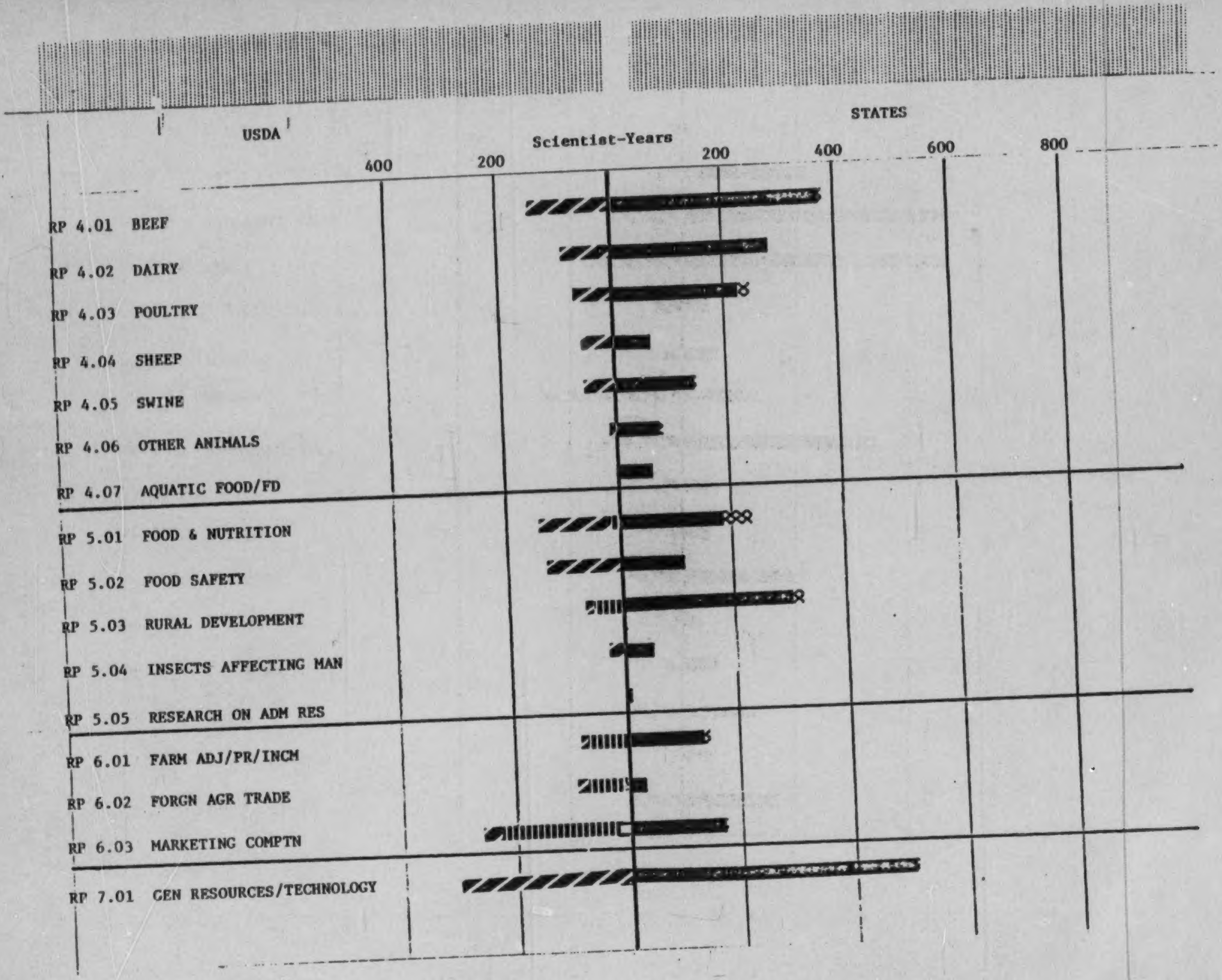

USDA
STATES
Scientist-Years
400
200
200
400
RP 3.01 CORN
RP 3.02 GRAIN SORGHUM
RP 3.03 WHEAT
RP 3.04 SMALL GRAINS
RP 3.05 RICE
RP 3.06 SOYBEANS
RP 3.07 PEANUTS
RP 3.08 SUGAR
RP 3.09 FRGE/RNGE/PAST
RP 3.10 COTTON
RP 3.11 TOBACCO
RP 3.12 NEW CROPS/OILSDS
RP 3.13 FRUIT
RP 3.14 VEGETABLE CROPS
RP 3.15 PLNTS ENHANC EVN
RP 3.16 BEES/OTH POL INS

(continued)


USDA
STATES
Scientist-Years
400
200
200
400
600
800
RP 4.01 BEEF
RP 4.02 DAIRY
RP 4.03 POULTRY
RP 4.04 SHEEP
RP 4.05 SWINE
RP 4.06 OTHER ANIMALS
RP 4.07 AQUATIC FOOD/FD
RP 5.01 FOOD & NUTRITION
RP 5.02 FOOD SAFETY
RP 5.03 RURAL DEVELOPMENT
RP 5.04 INSECTS AFFECTING MAN
RP 5.05 RESEARCH ON ADM RES
RP 6.01 FARM ADJ/PR/INCM
RP 6.02 FORGN AGR TRADE
RP 6.03 MARKETING COMPTN
RP 7.01 GEN RESOURCES/TECHNOLOGY

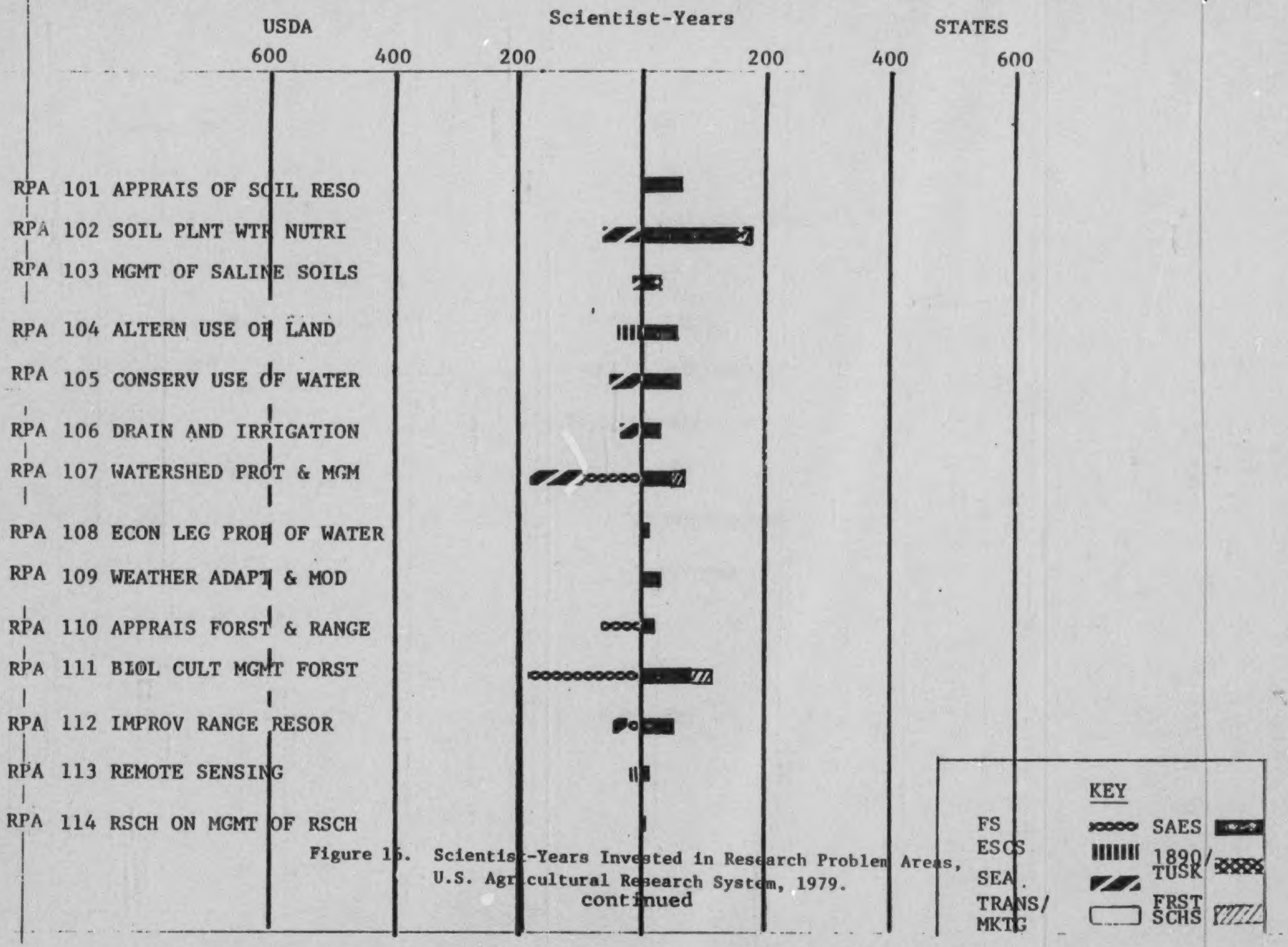
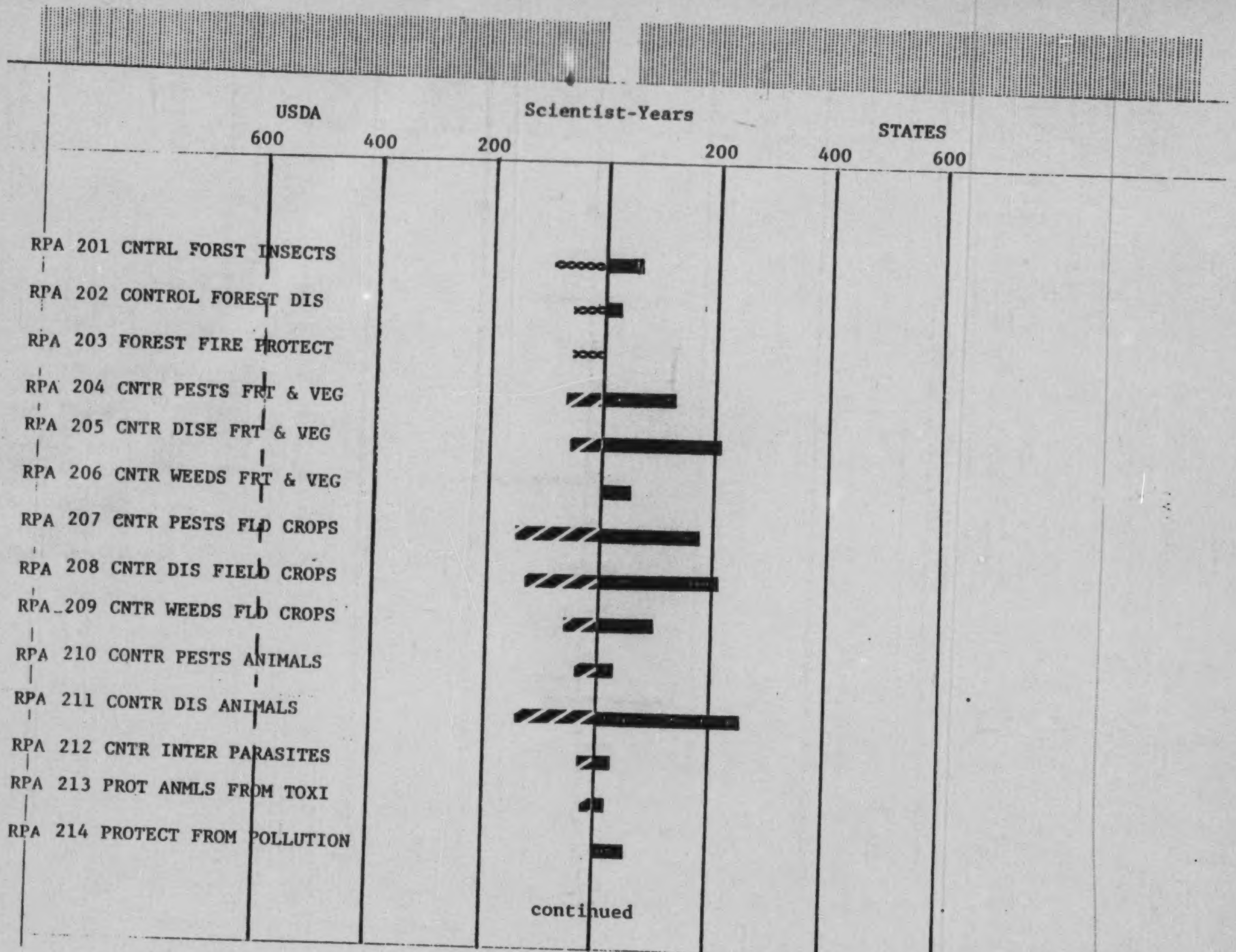
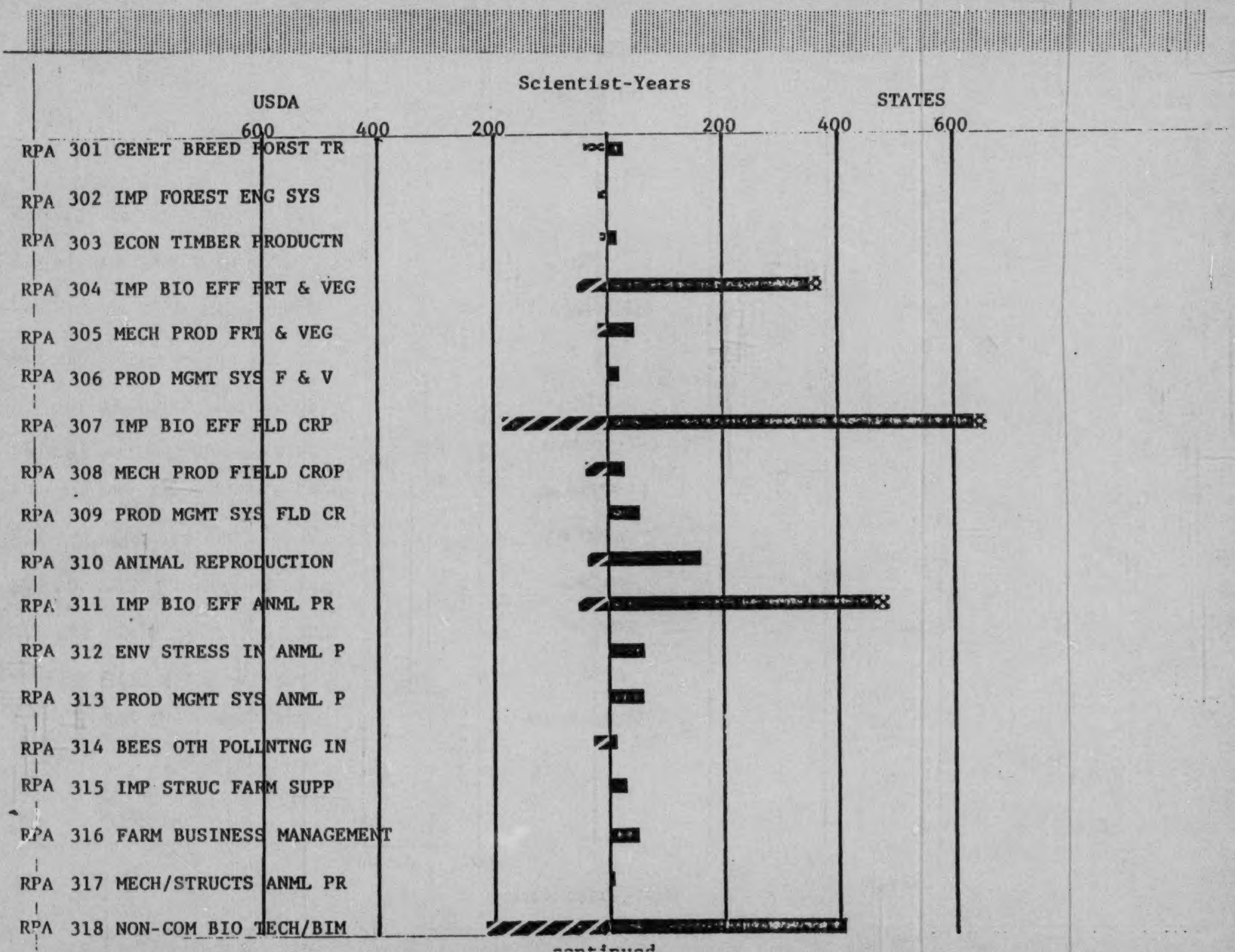


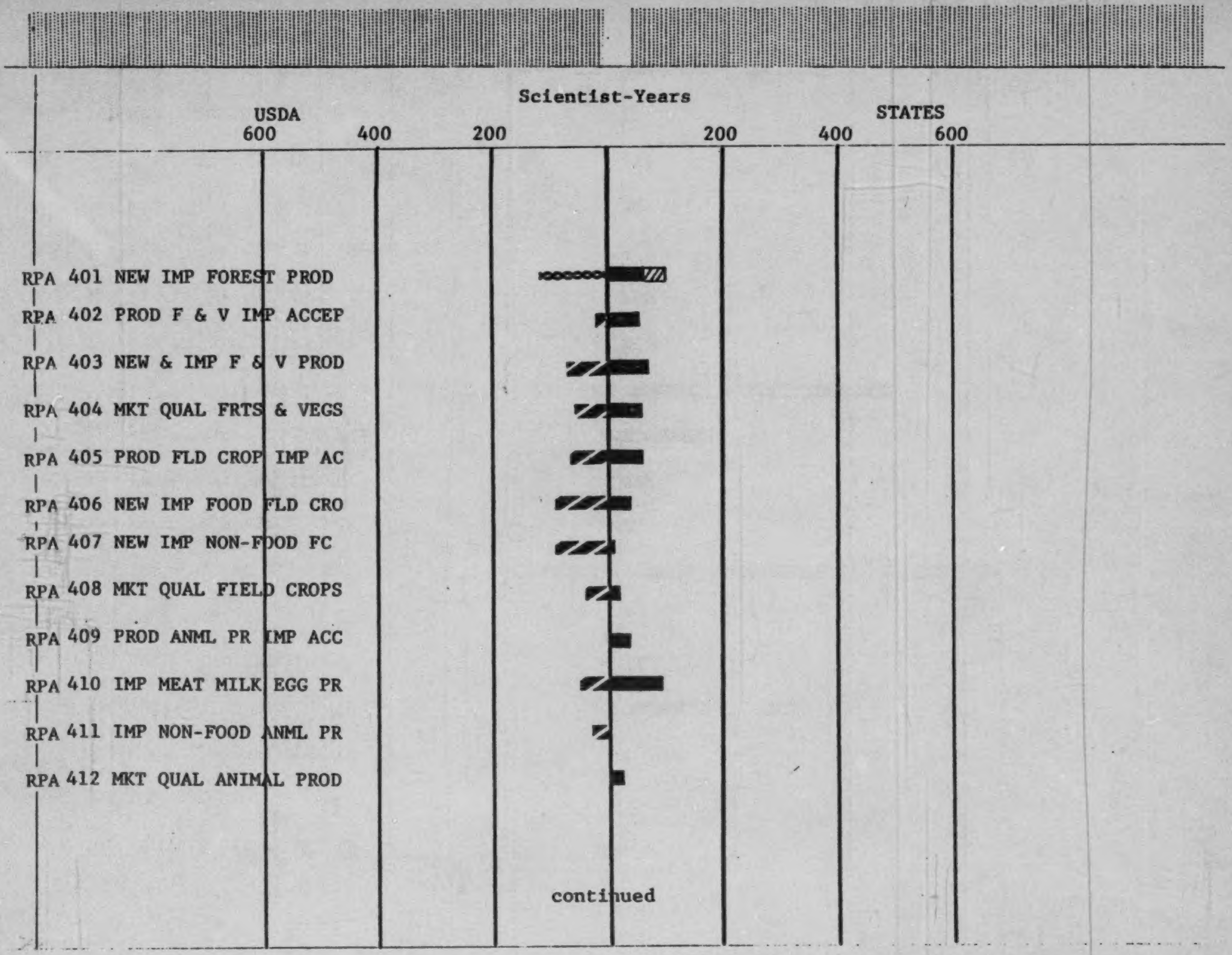
Figure 15. Scientist-Years Invested in Research Problem Areas, U.S. Agricultural Research System, 1979.
continued


USDA
Scientist-Years
STATES
600
400
200
200
400
600
RPA 201 CNTRL FORST INSECTS
RPA 202 CONTROL FOREST DIS
RPA 203 FOREST FIRE PROTECT
RPA 204 CNTR PESTS FRT & VEG
RPA 205 CNTR DISE FRT & VEG
RPA 206 CNTR WEEDS FRT & VEG
RPA 207 CNTR PESTS FLD CROPS
RPA 208 CNTR DIS FIELD CROPS
RPA 209 CNTR WEEDS FLD CROPS
RPA 210 CONTR PESTS ANIMALS
RPA 211 CONTR DIS ANIMALS
RPA 212 CNTR INTER PARASITES
RPA 213 PROT ANMLS FROM TOXI
RPA 214 PROTECT FROM POLLUTION

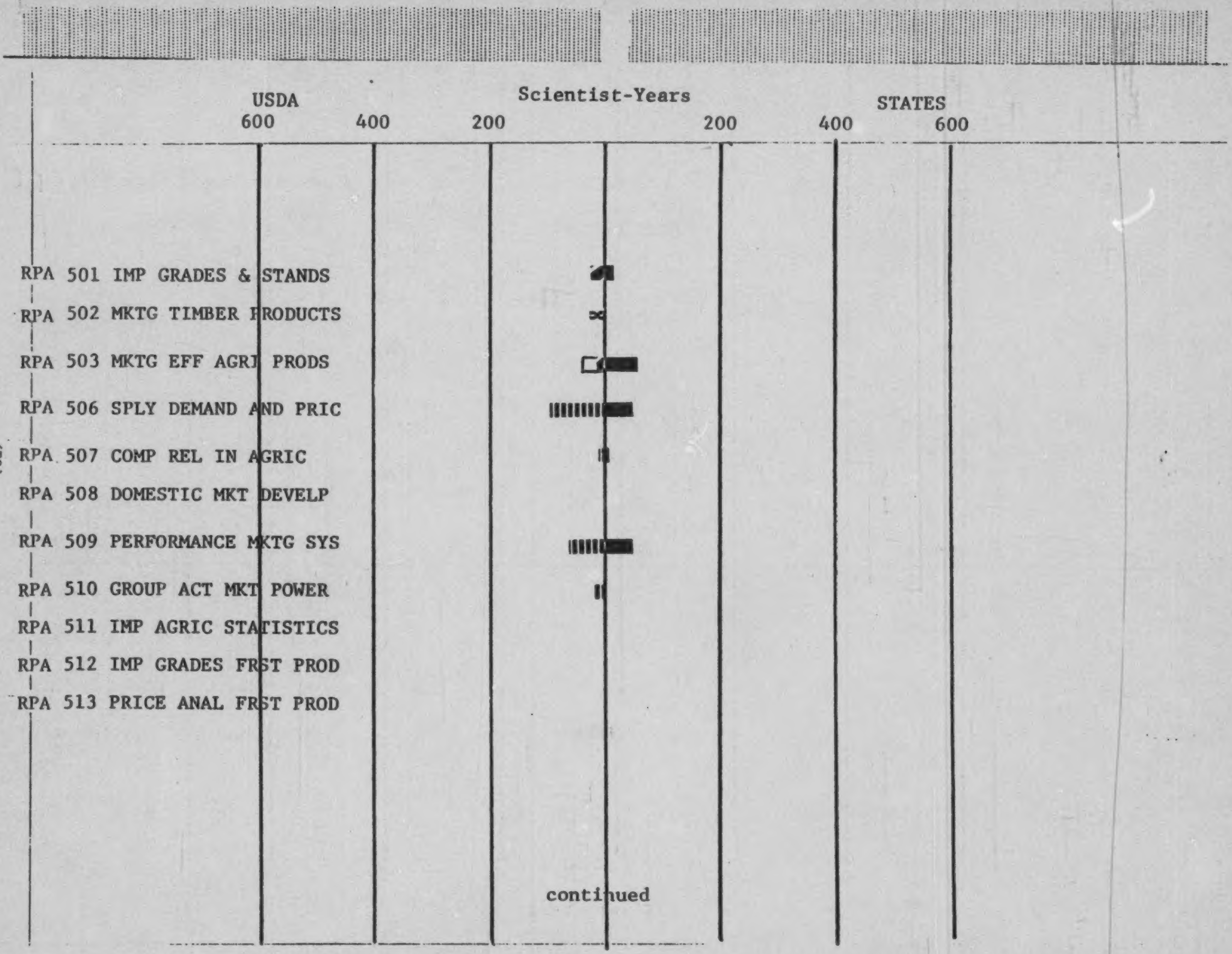
continued


Scientist-Years
USDA
STATES
600
400
200
200
400
600
RPA 301 GENET BREED FORST TR
RPA 302 IMP FOREST ENG SYS
RPA 303 ECON TIMBER PRODUCTN
RPA 304 IMP BIO EFF FRT & VEG
RPA 305 MECH PROD FRT & VEG
RPA 306 PROD MGMT SYS F & V
RPA 307 IMP BIO EFF FLD CRP
RPA 308 MECH PROD FIELD CROP
RPA 309 PROD MGMT SYS FLD CR
RPA 310 ANIMAL REPRODUCTION
RPA 311 IMP BIO EFF ANML PR
RPA 312 ENV STRESS IN ANML P
RPA 313 PROD MGMT SYS ANML P
RPA 314 BEES OTH POLLNTNG IN
RPA 315 IMP STRUC FARM SUPP
RPA 316 FARM BUSINESS MANAGEMENT
RPA 317 MECH/STRUCTS ANML PR
RPA 318 NON-COM BIO TECH/BIM

continued


Scientist-Years
USDA
600
400
200
200
400
600
STATES
RPA 401 NEW IMP FOREST PROD
RPA 402 PROD F & V IMP ACCEP
RPA 403 NEW & IMP F & V PROD
RPA 404 MKT QUAL FRTS & VEGS
RPA 405 PROD FLD CROP IMP AC
RPA 406 NEW IMP FOOD FLD CRO
RPA 407 NEW IMP NON-FOOD FC
RPA 408 MKT QUAL FIELD CROPS
RPA 409 PROD ANML PR IMP ACC
RPA 410 IMP MEAT MILK EGG PR
RPA 411 IMP NON-FOOD ANML PR
RPA 412 MKT QUAL ANIMAL PROD

continued


USDA
Scientist-Years
STATES
600
400
200
200
400
600
RPA 501 IMP GRADES & STANDS
RPA 502 MKTG TIMBER PRODUCTS
RPA 503 MKTG EFF AGRI PRODS
RPA 506 SPLY DEMAND AND PRIC
RPA 507 COMP REL IN AGRIC
RPA 508 DOMESTIC MKT DEVELP
RPA 509 PERFORMANCE MKTG SYS
RPA 510 GROUP ACT MKT POWER
RPA 511 IMP AGRIC STATISTICS
RPA 512 IMP GRADES FRST PROD
RPA 513 PRICE ANAL FRST PROD

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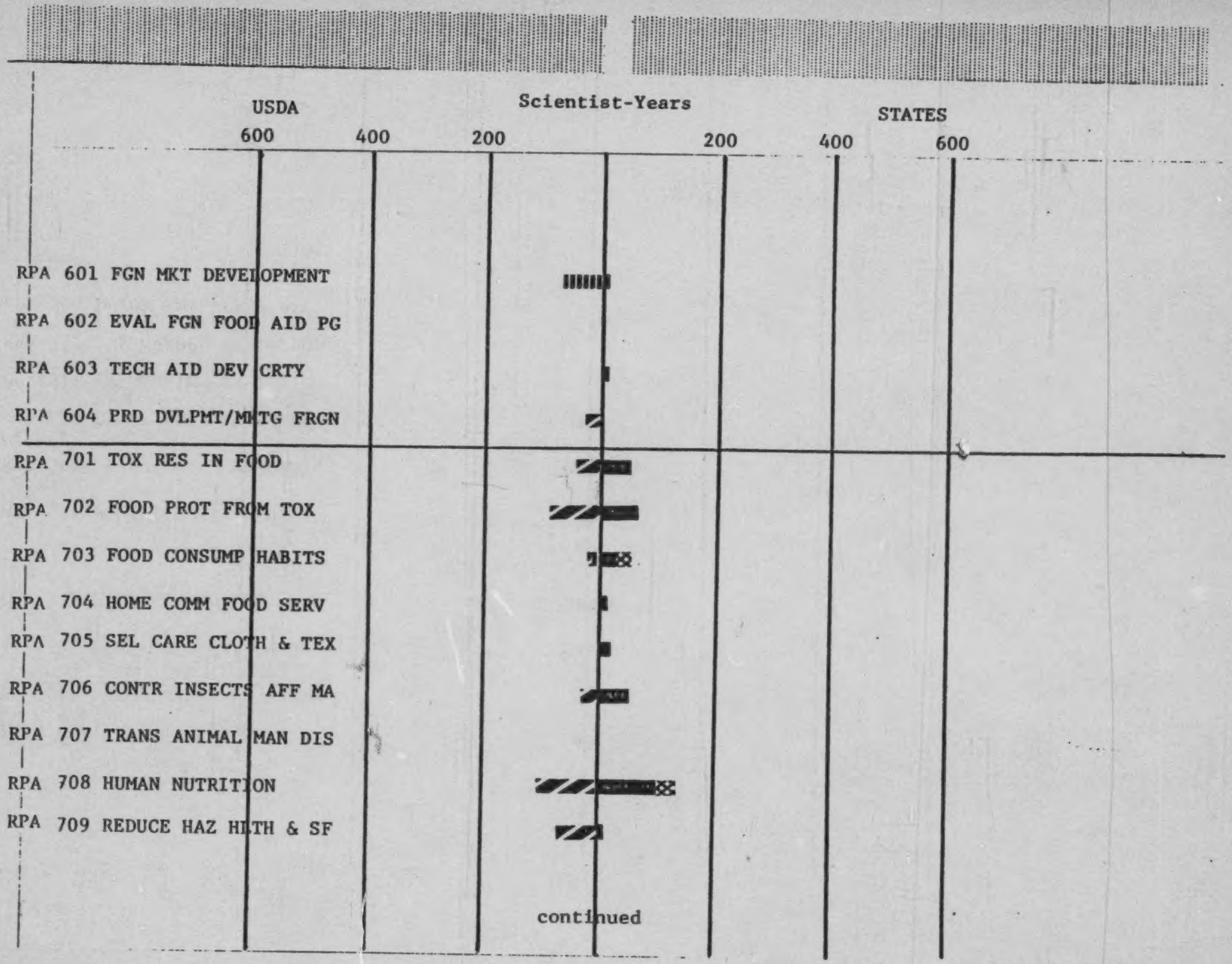
USDA
Scientist-Years
STATES
600
400
200
200
400
600
RPA 601 FGN MKT DEVELOPMENT
RPA 602 EVAL FGN FOOD AID PG
RPA 603 TECH AID DEV CRTY
RPA 604 PRD DVLPMT/MKTG FRGN
RPA 701 TOX RES IN FOOD
RPA 702 FOOD PROT FROM TOX
RPA 703 FOOD CONSUMP HABITS
RPA 704 HOME COMM FOOD SERV
RPA 705 SEL CARE CLOTH & TEX
RPA 706 CONTR INSECTS AFF MA
RPA 707 TRANS ANIMAL MAN DIS
RPA 708 HUMAN NUTRITION
RPA 709 REDUCE HAZ HLTH & SF

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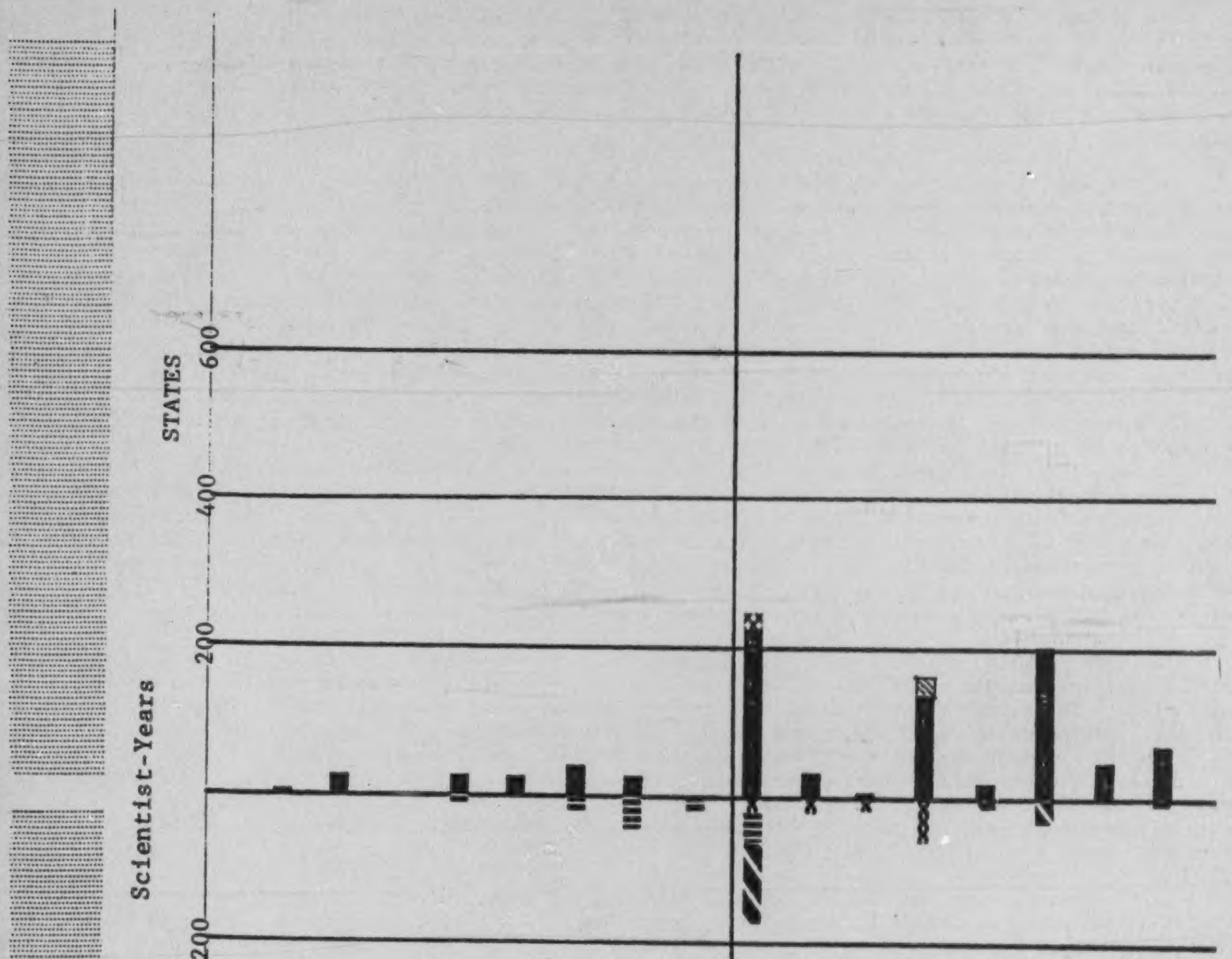

Scientist-Years
USDA
STATES
600
400
200
200
400
600
RPA 801 RURAL HOUSING
RPA 802 INDIV & FAM DEC MAKING
RPA 803 RURAL POVERTY
RPA 804 ECON POTENT RURL PEOPLE
RPA 805 COMMUNICAT RURAL PEOPLE
RPA 806 ADJUSTMENT TO CHANGE
RPA 807 AGRIC ECONOMIC CHANGE
RPA 808 GOVERNMENT PROGRAMS
RPA 901 ALLEV POLLUTION
RPA 902 OUTDOOR RECREATION
RPA 903 MULTI-USE-FOREST POT
RPA 904 WILDLIFE AND FISH ECOLOGY
RPA 905 TREES BEAUTIFICATION
RPA 906 ORNAMENT & TURF DEVELOPMENT
RPA 907 RURAL INCOME IMP
RPA 908 RURAL INSTITUT IMP

The number of commodities and commodity-related problems in every state far exceeds the number of disciplinary specialists in each and all agricultural sciences needed to address those needs specifically, comprehensively, and rapidly. Each Station, each agricultural science, and each discipline within that science has balanced its research program to meet as best it can both short-range and long-range needs of users, taking into account research efforts elsewhere in the nation.

In the North Central Region, the Stations are all large enough that they can maintain the minimal array of disciplines appropriate in most agricultural sciences to meet principal state needs, though not all state needs. Moreover, seven of the Stations historically have been and are among the top 10 Stations in the nation that support Ph.D. graduate research programs in nearly all agricultural sciences. The remaining six Stations include several Stations which have graduate research programs in selected agricultural sciences or disciplines that also are nationally ranked. The significance of graduate Ph.D. research programs is that they largely represent the strength and diversity of commitment to long-range needs, that is, basic research in agricultural sciences. It is also important to recognize that the faculties of these Stations are associated with faculties of many general science departments, e.g., biology, chemistry, physiology. The graduate research programs of those general science departments are among the nation's top Ph.D. graduate research programs in which basic research in general sciences is emphasized, some of which is relevant to agricultural sciences. So both kinds of basic research are being done side by side in a single university. In such graduate research institutions, the scientists are viewed as being best suited to determine priorities and opportunities in advancing basic research. The interactions among scientists in agricultural science and general science department are frequent and close enough to permit the agricultural scientist to judge the most appropriate means of addressing basic agricultural science needs. Moreover, USDA agency scientist commitments in the Region have not been as numerous as in other regions relative to the importance of the agriculture of the region.

In other regions, there is much more variability either in size of Station or in their historic role in graduate education at the Ph.D. level. The Southern Region is like the North Central Region in having uniformly large Stations but differs in that graduate education at the Ph.D. level historically was concentrated in only a few institutions. Now, however, the number of Ph.D. granting institutions and the number of Ph.D.'s trained has increased as a result of stronger state research support during the last 15 years. The South also has had larger personnel commitments by USDA agencies than other regions. Where once the Southern Region was best known for its strong orientation to applied research, it now has enhanced its reputation in basic agricultural science research.

In the Northeastern and Western Regions, Stations are quite variable in size. Many are able to maintain only minimal arrays of disciplinary specialists in selected departments. Fewer of them are able to maintain and support Ph.D. graduate research programs. As a consequence, they must rely more heavily on USDA research agencies and adjoining states to furnish applies and basic research critical in their attempts to satisfy user needs. It is important to remember, however, that irrespective of each Station's size or ability to meet state needs from its own resources, each of its scientists contributes to the national advancement of his discipline.

E. National Priority Setting

National priority setting occurs through three major avenues: (1) through the national organization of Experiment Stations and its voice, the Experiment Station Committee on Organization and Policy (ESCOP), (2) through the National Research Committee (JCFAS), a joint USDA-State Station priority setting mechanism, and (3) through the RRF, The Regional Directors' Associations, and the Committee of Nine. A fourth avenue is through several national science and commodity organizations. Some are through general science organizations, such as the National Academy of Science and the National Research Council, the American Association for the Advancement of Science, and in part through the National Science Foundation. Some are through agricultural science organizations: Agricultural Research Institute, professional societies of the agricultural sciences. Some are through commodity or trade groups. Priority setting in the three major avenues is closely related and usually reinforcing. If differs principally in emphasis.

Experiment Station System Priorities: ESCOP

ESCOP is responsible for the priorities of the Stations independent of their associations with the USDA research agencies. The principal priority setting occurs in the development of annual budget requests to the Congress through the USDA and the Executive Branch. These efforts are an outgrowth of the priority setting processes in the Regional Associations, which in turn are outgrowths of State Station priority setting processes. Concensus is approached, as Hubert

Humphrey said it, through "bottoms-up" planning and priority setting. At each level, State USDA, and other units are involved.

As noted earlier, two principal concerns of all Stations are (1) to acquire and maintain diversity of disciplinary specialization in each of the agricultural sciences important to the state, and (2) to maintain flexibility of resource use. These are permanent concerns.

Agriculture involves complex dynamic biological and economic systems. Change is a constant feature. Principal food species--crops and livestock--undergo continuing biological improvement and alterations through research. At the same time their pests, diseases, and associated helpful organisms are continually changing, too. The natural resources available to produce food change. Weather and climate change and are only modestly predictable. Economic circumstances change.

Food supplies must not be viewed as simply the product of changes in an economic demand-supply equation but as the product of a multitude of permanent but shifting battles with the unrelenting forces of nature.

In such circumstances, flexibility is the weapon that provides for reinforcing or for new attacks at vulnerable spots.

Those state concerns--science power and flexibility--long have been the principal concerns of ESCOP. Both are addressed best through continuing reliable and responsive funding mechanisms.

Science power is not achieved in agriculture in the same manner it is achieved in other sciences.

As is well known, the principal pool of Ph.D. research scientists in the United States is in the universities and colleges. (With a few exceptions--agriculture is one--federal department agencies themselves do not maintain large agency Ph.D. research staffs though they do indirectly support the maintenance of university research faculty pools through their grant and contract research programs.)

The size and diversity of the Ph.D. pool in most university departments is determined principally by the enrollment in departmental courses. Enrollments establish the base which then is expanded by federal grants and contracts. Both public and private institutions contribute to the pool. Enrollments and federal grants support Ph.D. training programs.

In agriculture, the situation is quite different. There are almost no private institutions; virtually all agricultural education is provided by one or a few publicly-supported state universities in each state. Agricultural course enrollments are much too small to provide the kinds of disciplinary specialization found in departments teaching general science courses required of many students. Thus, agricultural sciences differ sharply from other sciences in the general way in which public pools of scientific manpower are developed and maintained.

States have been able to provide agricultural sciences with what diversity they have only by concentrating Ph.D. graduate programs (with their associated and required research efforts) at a single land-grant university and by maintaining the State Agricultural Experiment Station there, too. Agricultural enrollments provides only a very few teaching assistantships for Ph.D. candidates so virtually all Ph.D. candidates must depend on the State Experiment Station for part-time employment.

A number of states also have one or more other state-supported colleges which offer agricultural training, particularly at the undergraduate level. Some of these now are staffed by Ph.D.'s who thus have been trained to conduct research and to supervise Ph.D. candidates. Despite those qualifications, state legislatures in nearly all states have refused to provide them funding for research or for Ph.D. programs.

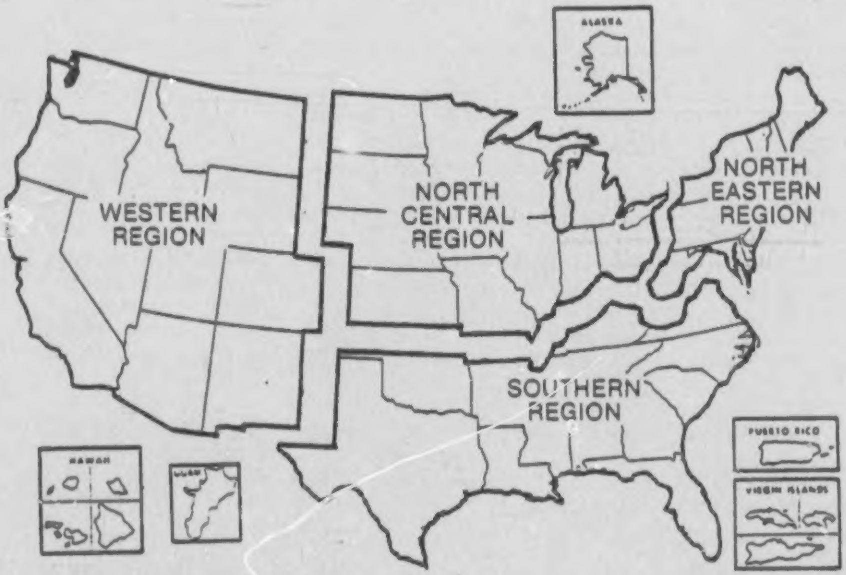
Even with the legislatively mandated concentration of research and Ph.D. programs (at a single university), most land-grant colleges and State Experiment Stations find it difficult to maintain both the critical mass and minimal critical array of scientific specialists appropriate to state needs, much less provide adequate and flexible support resources.

These are the reasons that ESCOP's first priority for federal support has been to maintain and strengthen current formula programs. Current formula programs support a sizeable basic research effort in agricultural sciences. They also are balanced with respect to commodity needs and opportunities. As noted earlier, formula programs also include special federal initiatives to

Figure 17

Regional and National Planning Committees
Interim National Research Planning Committee

1979—84 Cycle for Projecting and Analyzing Research Program Adjustments With Historical Trends and Comparisons


ALASKA
WESTERN REGION
NORTH CENTRAL REGION
NORTH EASTERN REGION
SOUTHERN REGION
HAWAII
GUAM
PUERTO RICO
VIRGIN ISLANDS

A Report to the Joint Council on Food and Agricultural Sciences strengthen forestry, 1890 colleges, rural development, and animal health. Too often, however, federal initiatives seem to be modelled on efforts more appropriate for other sciences than for agriculture.

ESCOP's second priority has been to augment basic research already supported under the formula programs. That might be done in two ways: (1) through formula funds earmarked for basic research, or (2) through competitive grant programs. The USDA and Congress to date have chosen only the Competitive Grants Program. ESCOP has supported the Competitive Grants Program. However, that program does not permit Stations to employ new disciplinary specialists; moreover, it employs scarce resources less efficiently than a formula-fund basic research program.

National Research Planning Committee Priorities

Representatives of the Stations, USDA agencies, other institutions cooperating with the USDA on federal initiatives, and industry are included in the National Research Committee. The priorities identified by the National Research Committee result from aggregating the priorities of the four Regional Research (Planning) Committees. These are identified every two years and are published as five-year projections of research administrators (Figure 17). Other priorities have been developed at special conferences such as the Kansas City Conference initiated by the USDA.

Regional Research Fund Priorities: National Synthesis

RRF priorities emerge out of the Regional Directors' Associations and are acted upon by the Committee of Nine. They represent priorities principally of the Stations but also include USDA input.

Priorities of National Science and Commodity Organizations

Various agricultural science professional societies have developed lists of priorities prepared by member scientists. These normally have been considered early in the state and regional priority setting processes because the scientists preparing the lists are employed by the USDA and the Stations.

The National Academy of Sciences and the American Association for the Advancement of Science also have sponsored priority setting conferences. These also normally are considered in state and regional planning efforts, often before the conference has been held.

Various commodity and trade association groups also have developed priority lists used by the National Research Committee.

F. National and Regional Priority Setting--The New Structure Provided by Title XIV, Farm Bill of 1977

In 1977, Title XIV of the Farm Bill of 1977 created the Joint Council on Food and Agricultural Sciences and a National Agricultural Research and Extension Users Advisory Board.

The Joint Council is to foster coordination of teaching, research, and extension in agricultural sciences. Its membership includes one representative of each principal USDA agency; one representative for all State Extension Services; one representative for all State Experiment Stations; one representative for all land-grant colleges; one for non-land-grant colleges; one for private universities; one for 1890 colleges; and one for industry. Thus, representation is not proportionate to responsibility of the participating groups. The Joint Council created four Regional Councils and 12 Regional Committees (Research, Extension, and Teaching). Like the United Nations, the Joint Council may require a number of years to develop whatever effectiveness it can develop.

The Users Board has a broad-based representation. Much of its time has been devoted to public hearings in various sections of the country. Its research priorities have been very similar to those developed by the State-USDA Agricultural Research System through more complex and systematic approaches.

CHAPTER VI

SOME UNRESOLVED DILEMMAS

A. Contrasting Perspectives of the Congress, The State Legislatures, the State Agricultural Experiment Stations, the USDA, and the Universities and Colleges

Citizen demands of the Congress and the state legislatures have increased dramatically in scope and complexity. Agricultural research is just one of thousands of needs. Yet food is a primal element in the health, survival, and economic well-being of all citizens. Food and fiber comprise the largest sector in the national economy and in the economies of many states. They are major elements of foreign trade. Until very recently, public investments in agricultural research seemed large enough and so profitable that they could meet national and state needs comfortably. Now, as one looks ahead for the next two decades or longer, that does not seem true for numerous reasons.

In 1977, the Congress directed the USDA to provide national leadership not only in agricultural research but also extension and teaching. That was a role the USDA had never had not attempted to assume heretofore.

The role was made awkward and difficult by policy and budget decisions and recommendations of the USDA during the 1960s and 1970s. The USDA had had no responsibility for teaching until the Bankhead-Jones funds were transferred from HEW to USDA. Shortly after the transfer, the Secretary recommended discontinuance of the Bankhead-Jones funds and repeated that recommendation year after year. The Department which depended on land-grant institutions to train its scientists turned its back on that activity in a time when land-grant colleges and Experiment Stations were struggling desperately to accommodate a huge influx of students without adequate additional resources.

With regard to research, the USDA had steadily increased in-house research at the expense of partnership programs. It supported new initiatives outside the partnership system without much concern over their effect on the partnership or on the prerogatives of state government in determining its programs. In the face of obvious worsening in long-term food supplies of the world, it gave research low priority relative to that given research by other federal agencies.

In the intervening three years, the USDA's efforts (principally at the level of the Secretary and OMB) have not inspired confidence among those units charged by the state legislatures with corresponding state leadership responsibilities. A new administrative unit, the Science and Education Administration, was created in the USDA to provide leadership. This new leader of that unit has the confidence of the participating groups. However, numerous organizational and personnel changes in SEA have and are taking place. It is difficult to predict at this time what ultimately will emerge.

In the universities and colleges, student enrollments are expected to decline sharply. Some land-grant universities likely will be little affected, but others may be seriously affected. If agricultural enrollments drop, the number of potential graduate students in agricultural sciences may also drop. This will affect agricultural research in two ways. First, the Stations rely heavily on graduate research assistants to conduct research. Second, the Stations and the USDA depend on Ph.D. programs to supply agricultural research scientists. That supply may shrink. In many agricultural sciences, the supply of scientists is already critically short.

Enrollment changes may alter the universities' priorities relative to Experiment Station research despite the needs of users, the state, and the nation. If agricultural enrollments drop in the land-grant colleges, the number of teaching faculty may also drop. That will force a reduction in the diversity of the Station research faculty.

B. The Conflict Among Users' Principal Concerns

In Chapter II, the conflicts between the short-range and long-range needs of users was identified. Also identified was the conflict between the needs of users of proprietary products and services for research to enhance those products and services and the reluctance to use public resources for such efforts. In these issues, the USDA has provided uninspired and often woefully uninformed leadership.

C. National Priorities: Where and How Determined

National priorities may emerge as a product of sequential deliberations at the state, regional, and national level. Or they may emerge as did such issues as mechanization, post-harvest technology, small farms, organic farming, and antidesertification at the national level without prior state or regional concurrence. The USDA took upon itself to identify such emerging issues as national concerns. The interests and concerns of special topics are important. But clearly, a balanced view of agriculture is also an appropriate goal of a Department of Agriculture.

The Congress often has focused more intently on short-range immediate, and localized priorities and less intently ~~on long-ran~~ge priorities.

D. Proprietary Versus Public Research

Recent national efforts to restrict arbitrarily public research to those issues not addressed in the public sector demonstrated the complexity of certain research relationships. Proprietary research is secret and likely will remain secret. How is public research to avoid doing what it does not know someone else is doing?

Commissioned Paper II

FORCES AFFECTING FOOD AND AGRICULTURAL RESEARCH DECISIONS

Ron Knutson, Don Paarlberg, and Alex McCalla

Office of Technology Assessment

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The purpose of this paper is to discuss the forces that affect how food and agricultural research decisions are made in practice. In doing so it will provide a contrast between a usual description of the decision process using aids such as legislation, legislative history, organizational charts and committee structures and the realities of the decision process.

It is not unusual that differences exist between the theory and practice of decisionmaking. In reality, decisions are not made by organization charts and committees. They are made by individuals influenced by factors such as the setting of events within which the decisions take place, the power relationship among the individuals and organizations involved in or affected by the decision and political considerations. They are affected by annual reviews by legislators in the appropriations process. The fact that differences exist between the theory and reality of decisionmaking has no direct normative implications for the quality of the decisions that are made. That is, decisions may be better or worse or no different than if they followed strict organizational patterns.

A knowledge of how research decisions are really made is important. Research decisions influence: (1) what specific research is undertaken; (2) the distribution of research dollars among researchers, research institutions and research projects; and (3) the ability to solve particular problems facing mankind. An analysis of the research decision process also makes it possible to evaluate the effectiveness of alternative means of developing and implementing research priorities.

In specific terms this paper will attempt to:

1. Explain the changes that have occurred in the overall political, economic and scientific fields that influence the research decision process.
2. Explain the means by which identified research priorities are implemented at federal and state levels.
3. Discuss the factors that influence the individual research decisions of scientists.
4. Suggest methods by which the system might be improved.

Changing Forces Influencing the Research Decision Process

The political, scientific and economic environment within which decisions are made has substantial impact upon the quantity, quality and type of research undertaken. Major shocks to the system can have research impacts extending far beyond the immediate event. For example, the Soviet launching of Sputnik into space in 1957 resulted in a series of presidential, congressional and state legislative decisions that dramatically increased support for research. Agricultural biological research was an indirect beneficiary of this event.

Despite our success in putting a man on the moon, some of the glamour associated with research wore off by the early 1970's. Questions increasingly arose as to whether science was infallible in solving the nation's problems. The externalities of research in terms of environmental impacts, technological displacement of workers and quality of life were called into question. Campus protests and government scandals resulted in reduced confidence in both government and universities as a means of solving problems.

In spite of increasing concern about the adequacies of world food supplies in the early 1970's, research budgets were caught in a crunch between reduced appropriations and inflation.

These developments set the stage for the major forces and events influencing research decisions in the 1980's.

World Food and Political Situation

Two events in the early 1970's shook confidence in our ability to feed an ever-expanding world population. First, the southern corn leaf blight in 1970 reduced corn production in the U.S. by about 16 percent in terms of bushels per acre. Second, the combination of unfavorable weather conditions and the purchasing strategies of centrally planned economies led to uncomfortably low grain stocks and high prices from 1973 through 1975.

This combination of events resulted in several assessments of the world food situation and its ability to feed an ever-expanding population (National Academy of Science, 1977; USDA 1974 and 1979; United Nations World Food Conference). While the specific wording of the conclusions of these assessments varied, the consensus of the studies recognized:

1. That the world supply-demand balance was tighter in the 1970's than in the 1960's.
2. That periodic spot shortages of food could be expected in the years ahead with the potential for shortages becoming increasingly chronic.
3. That more trade in agricultural products would be required to satisfy increasing demand for food.
4. That government policies should be oriented toward obtaining increased production of food, providing for food reserves and expanding programs of nutritional assistance.
5. That need exists to give increased attention to the quantity and quality of resources available for food production including the need for larger public and private expenditures for agricultural research that expands output and increases productivity.

The need for increased public support for research is a remedy for a potential world supply-demand imbalance highlighted in the National Academy of Science, World Food and Nutrition Study. The study emphasized the need to augment the rate of increase in average crop yields in developing countries from 1.9 percent per year in the 1960's to 2.5 percent over the next 20 to 25 years (p. 2). To do this the study recommended increases in U.S. food and nutrition research appropriations of $210 to $230 million per year over the next four years beginning as early as FY 1978-1979 (p. 19). Such an annual increase would amount to roughly 20 percent of FY 1976-1977. public food and agricultural research appropriations. In addition, the study recommended substantially increased U.S. commitment to basic research and to research designed to increase production internationally.

The recommendations of the World Food and Nutrition Study have been only partially implemented. Since the study recommendations were made available to the Congress and the President, USDA appropriations for food and agricultural research have increased only 6 percent annually. State appropriations have increased 8 percent annually. In addition, a special grants program to support basic research has been established within USDA. Prior to the study recommendations, Title XII of the Foreign Assistance Act was enacted into law. Title XII had as its primary objective to provide increased support for the land-grant university system involvement in international agricultural development activities.

The unwillingness of Congress and the executive and state governments to provides funds for full implementation of the recommendations of the World Food and Nutrition Study likely relates to a mixture of the following factors:

1. The fact that by the time the study recommendations were made the existence of a tight food supply-demand balance was less evident. In fact, by 1977, the U.S. problem had temporarily changed to one of surpluses, low farm prices and low incomes. No domestic organized constituency thus existed in support of the recommendations for substantially increased research funding.
2. Pressures to control government spending existed at both federal and state levels.
3. The fact that the Academy of Science study was initiated by President Ford (a Republican) and became available only after President Carter took office.
4. Concern exists on the part of the U.S. agricultural establishment that additional support for international agricultural development research would lead to increases in production abroad that are competitive with the production of American farmers. The palm oil experience of the early 1970's is illustrative of American farmers' concern. Farmers and their organizations were therefore reluctant to support increased research with a signficant international thrust.
5. A perception exists that the land-grant system's support of international research was less than enthusiastic. Producers have from time to time been openly opposed to use of state funds to develop production abroad. Reality indicates that only four international development positions have been consistently supported by permanent funds in two land-grant universities. Concern exists that additional funding would be used simply to augment existing resources as opposed to supporting major new program thrusts. On the other hand, the record of the land-grant system in training scientists for both domestic and international research endeavors has been outstanding.

Regardless of the merits of specific conclusions and recommendations drawn from the world food situation and developments surrounding it, the problem of an increasingly tight world supply-demand balance remains. Barring major production breakthroughs based upon either an expanded resource base or technological developments, the world food problem is likely to become increasingly complex through at least the year 2000. Since the development of a substantially expanded agricultural resource base appears unlikely, technological change bears much of the burden for expanded food production.

Agricultural Productivity

On an input-output basis American agriculture is highly productive -- maybe the most productive in the world. Technological advances in addition to the quality of land, plentifulness of the rainfall, public investments in land and water development, the availability of high quality inputs and the profit motive all contribute to this high productivity.

Since the early 1970's increasing concern has existed that (1) the rate of increase in the productivity of American agriculture may be declining and (2) the backlog of scientific knowledge to be applied to agriculture may be decreasing. The problems of measuring both productivity and scientific backlog are sufficiently complex and elusive that quantification of precise magnitudes or even trends is difficult. Stated differently, it is easier to talk about the problems of productivity and scientific backlog than it is to quantify their dimensions.

The problems of quantifying trends in productivity are illustrated by a 1975 National Academy of Science assessment of agricultural productivity trends and by the fact that the American Agricultural Economics Association has had a major committee effort to evaluate alternative means of improving agricultural productivity estimation procedures. While the Academy of Science study expressed concern about potential reductions in agricultural productivity, it had little in the way of evidence to support its concern.

Statistical measures of productivity that are available suggest that considerable variation in the rate of increase in productivity has historically existed at different time intervals. A recent study by Evenson indicates the following major periods of change in productivity as measured by the ratio of total agricultural output to total inputs (Evenson).

Years	Annual average rate of change in productivity
	Percent
1870-1910	1.0
1911-1925	0.0
1926-1933	0.75
1934-1944	2.5
1945-1952	1.0
1953-1965	3.5
1966-1971	1.0
1972-1979	2.0

The Evenson study clearly indicates that during the past century there were at least three periods when agricultural productivity declined -- 1911-1925, 1945-1952, and 1966-1971. These periods can be readily associated with specific events in agricultural history. For example, reduced productivity in 1910-1922 can be explained by labor drawn away from agriculture in World War I and a post-war collapse of farm prices and incomes. Likewise in 1944-1952 the effects of World War II were prominent. Men were drawn from the farm and after the war many did not return. The result was the employment of extensive farming techniques. The period 1966-1971 was characterized by government efforts to control production. Up to 60 million acres of farmland were removed from production. Intensive farming was employed on the remaining acreage.

The years of rapid increases in productivty, 1933-1944 and 1953-1965, had their own uniqueness. In 1933-1944 hybrid corn, lime fertilizer and farm mechanization combined to result in rapid productivity increases. From 1953-1965 the U.S. entered the era of chemical farming, improved use of fertilizer, increased mechanization and increased irrigation of farmland.

Throughout this period of 110 years, four major scientific breakthroughs are generally cited as having major immediate productivity-enhancing impacts: (1) the tractor, (2) hybrid corn, (3) the mechanical cotton harvester and (4) hybrid sorghum. Other scientific productivity-enhancing developments such as the development of agricultural chemicals and artificial insemination were more gradual and involved a combination of multiple management factors in their effective application.

The evidence to substantiate a decline in the rate of increase in agricultural productivity is not readily apparent. Evidence to support a decline in the backlog of technology available for innovative development and adaptation by farmers is even less clear. Whether such a drop in technological backlog in fact exists cannot be verified.

It is known that research can best be carried out on a continuous basis. It cannot readily be turned on and turned off. The practices and technologies that will be available to sustain and enhance agricultural productivity in the future are being developed in the scientific laboratories today. It is impossible to foresee which scientist, research product or research institution might produce the next major productivity-enhancing breakthroughs.

Industrialization of Agriculture

Public support for food and agricultural research has been based upon the public interest in an adequate and stable supply of food at reasonable prices. Realization has traditionally existed that farmers, either as individuals or groups, have neither sufficient economic incentive nor scale of operation to conduct their own research and education programs. In addition, it was understood that the existence of a competitive agricultural structure would result in rapid adoption of new technology by farmers. That is, the first farmers to adopt the new technology would benefit in terms of lower costs and higher profits. As more farmers adopt, output would increase, farm product prices would decline and consumers would be the ultimate beneficiary. Cochrane refers to the process of continuous infusion of new publicly supported technology into agriculture and the price of depressing economic consequences of it as the agricultural treadmill.

The justification for public support for agricultural research is still prominently used today. While it still has merit, many changes have occurred in the structure of agriculture that can significantly change the distribution of benefits among participants in the agricultural production marketing system including input suppliers, farmers, marketing firms, retailers and consumers. Some refer to this process of change in the structure of agriculture as industrialization; others suggest that agriculture is simply losing its uniqueness. (Barr; Paarlberg, 1980).

Trends toward an industrialized agriculture was well documented. One of the best recent reviews of these structural trends and forces on a commodity basis is a series of papers published by the Senate Committee on Agriculture, Nutrition and Forestry. These papers indicate that trends toward industrialization are most prominent in the livestock industry. Considerably greater debate exists with respect to future structural trends in crop production which varies from the highly integrated system of fruit and vegetable production to the dispersed agriculture of the Corn Belt (Knutson, 1979, 1980).

In addition to the trends in the structure of farming, input supply food processing and retailing functions are sufficiently concentrated that these firms possess substantial market power (Power and Conner). Biere, de Janvery and Schmitz demonstrate that the existence of such market power relationships has a profound effect upon the distribution of benefits from technological change. Industrialization of agriculture thus affects the distribution of benefits from public research that supports or facilitates technological change. The first beneficiaries of technological change are the innovative input suppliers who adopt and mechandize new technology to producers. The second beneficiaries of technological change are the first adopters. These are frequently larger farmers that have superior access to capital markets, information and education. Those farmers who do not or cannot adopt find themselves increasingly squeezed by the effect of lower prices (Paarlberg, 1980). The benefits of reduced farm prices can be delayed in reaching consumers by the intervening market position and superior market power of food marketing firms, processors and retailers.

Trends toward industrialization of agriculture add credibility to the arguments of Hightower expressing concern about close ties between large farmers, large agribusiness firms and the research establishment (including both the USDA and the land-grant university system). In retrospect, the strong negative reaction of the research establishment to *Hard Tomatoes, Hard Times* was likely a result of Hightower's effectiveness in pointing out a very real problem area. Reality suggests:

1. Large farmers do have more influence than smaller farmers on the research and education programs in both the land-grant system and USDA. Large farmers are more actively interested; they are more likely to attend meetings or be directly "plugged in" to the research scientist and university administration. While the system is open to anyone, some farmers take advantage of it more than others.
2. Food and agricultural research are not neutral with respect to structure. Technology has favored larger and more mechanized farms. It has made it more difficult for smaller farmers to survive and young farmers to enter agriculture. It has, however, also reduced the cost of food to consumers (Brooks).
3. Input suppliers, including machinery, fertilizer and chemical manufacturers as well as seed suppliers do benefit from public research. The magnitude of these private bene-

fits would be expected to be directly correlated to the extent to which the research results are a "public" as opposed to a "private" good and the competitiveness of the market in which the input suppliers are involved.

4. Food processors, marketing firms and retailers benefit in much the same manner as input suppliers from post-harvest research. They likewise have sufficient market influence to delay, although not prevent, the benefits of research from reaching the consumer.

The magnitude of these problems has not been adequately researched. The existence of them does not negate either the need for or the justification for publicly supported food and agricultural research. It does suggest the need for awareness on the part of research administrators and scientists of their public responsibility to assess the distribution of benefits from specific research projects undertaken.

Recognizing the trends toward industrialization of agriculture, one of the favorite arguments of Office of Management and Budget officials has been that agriculture has progressed to the point where large expenditures on public research are no longer needed. The implication is that proprietary agribusiness firms and cooperatives have sufficient resources to conduct their own research.

This argument has traditionally been used with respect to post-harvest technology research. Secretary Bergland used it in California to call for a restriction on labor-saving mechanization research. In the future, the argument can increasingly be expected to be used with respect to nearly all technology-related agricultural research.

One has difficulty disputing the point that many agribusiness firms have sufficient resources to conduct more agricultural research. Some studies suggest a definite need for them to be more involved in research (French, et al.).

It is not at all clear, however, that proprietary agribusiness firms and cooperatives would, even in today's market setting, carry out an agricultural research program commensurate with either present levels of funding within the USDA land-grant research system or the level needed to meet future world food needs. This is particularly true of high-cost, high-risk basic research. It is clear that if this research were to be carried out by the private sector, it would be the sole property of individual firms doing the research. The cost of the research plus a return on investments made would clearly be reflected in the price of inputs used by farmers as well as the food purchased by consumers. If the educational function were to be performed by individual firms as opposed to the extension service, objectivity would clearly suffer. Much of the education would be on a trial-and-error -- buyer beware -- basis.

Research administrators and scientists do need to be cognizant of the need for public interest objectivity in research decisions. They likewise need to consider the distribution of benefits from their research. This situation requires that public research administrators:

1. know and carefully consider the specific origin of each research proposal;
2. evaluate the clientele more likely to benefit from specific research proposals;
3. protect the confidentiality of the results until they are released to the public;
4. avoid studies that have specific confidential firm outlets.

New Agenda Issues

In addition to food shortages and the continuing process of industrialization, the 1970's were shocked by a host of new issues and concerns that will continue into the 1980's (Paarlberg, 1975, 1980). Demand developed for more generous food programs, organization rights for farm labor, lower food prices, increased food safety, increased occupational safety, increased environmental protection, sharing water rights, equal rights for agricultural minorities and improved nutrition.

Traditional agricultural interests in increasing production efficiency were put on the defensive. Systems of production and processing which the agricultural research and extension system had a hand in developing and implementing were attacked. Examples include agricultural chemicals banned by the Environmental Protection Agency, commercial fertilizers leaking into streams and lakes, runoff from large-scale feedlots made possible in part by continuous feeding of antibiotics, and abuse of antitrust restraints by milk cooperatives that were encouraged to unite and advised by USDA and land-grant university economists.

The problem presented to the research establishment by this new agenda of issues was complicated by rapid increases in energy prices and interest rates. Modern agriculture is both energy- and capital-intensive. Farm costs escalated rapidly while new demands were being placed on the agricultural system by legislation, regulation, judicial decisions and societal pressures.

The reaction of farmers and agribusiness to these developments has basically been one of confrontation -- attacking government regulators for imposing needless costs on their businesses. Unfortunately, at times university and USDA scientists have been drawn into the battle to justify particular positions. More often than not, the result has been a loss of credibility.

A much larger quantity of university and USDA scientific resources has legitimately been devoted to: (1) clarifying the asserted cause-and-effect relationship, (2) discovering alternative means of dealing with problems created by the new agenda developments and initiatives and (3) cultivating and serving the needs of the nonfarm clientele.

These changes suggest a need for major changes in the orientation of food and agricultural research within both USDA and the universities. Examples include:

1. A dramatic increase in research that recognizes increases in land energy prices and the need for conservation of energy and water.
2. The development of new systems for controlling diseases and increasing productivity that have neither an adverse environmental impact nor jeopardize the safety of the food supply.
3. The development of new programs of research which give due consideration to the social interest in nutritional needs, quality of life and equitable treatment of those who have an interest in food and fiber.

Legitimate concern exists within the agricultural research establishment that absent substantial increases in research funding, this new agenda of issues had drained away resources from traditional agricultural research interests associated with increasing production and efficiency. Some research administrators have found themselves in a difficult position overtly making the case to serve the new agenda constituents while retaining the support of farmers and agribusiness interests. Without substantial increases in budget support many administrators have been unwilling to "bite the bullet" and redirect major budget segments to foster research programs that have legitimate appeal to the new agenda constitutent groups (McCalla).

Shift to More Basic Research

The surfacing of the world food problem in the early 1970's combined with the realization of agriculture's dependence on increasingly limited energy and water resources created a call for more basic agricultural research in addition to the previously discussed appeal for increased public support for research (National Academy of Science, 1975). Concern existed that, without major scientific breakthroughs in agriculture's capacity to produce, the world may not be able to satisfy future food needs. This concern was fostered by advocates in the scientific community contending that discovery of new knowledge was lagging.

Three areas were identified as having particular potential for generating such major breakthroughs -- biological nitrogen fixation, photosynthetic efficiency and the restructuring of genetic material (Office of Technology Assessment). Basic research in each of these areas was determined to be necessary to provide the needed breakthrough in knowledge. Realization also existed that breakthroughs could be most efficiently accomplished and problems most readily solved if they were attacked on a multidisciplinary approach -- as opposed to traditional disciplinary lines.

Throughout and prior to this period increased sensitivity existed that the land-grant system did not have a monopoly on research ability in agriculture. This feeling was particularly strong with respect to basic research in the identified areas. Considerable basic research with potential application to agriculture was in process in non-land-grant universities and in departments such as biology or biochemistry outside the funding of the agricultural experiment stations but within the land-grant system. Much of this basic research was supported by grants from the National Science Foundation. While debate still exists regarding the transferability of this research to applied uses, the fact is that mechanisms did not exist to overtly integrate this research and expertise into the agricultural system.

The Food and Agriculture Act of 1977 was responsive to the perceived need for more basic research. The Act explicitly provided for the creation of competitive research grants within

USDA. Competitive grants using a system of peer review was foreign to the USDA research program where research funds were traditionally allocated to the states on the basis of formula.

Formula funding had given university research administration maximum latitude for the allocation of research funds. The research administrator was the czar of research decisions -- or thought he was. In this setting, competitive grants were viewed as a direct threat to control of the land-grant agriculture research program. To add insult to injury the competitive grants program was opened up to proposals from scientists outside the agriculture research establishment.

The 1977 Act also created the Joint Council to oversee, advise, coordinate and set priorities for research within USDA. This structure was designed to replace the previous research policy committee referred to as ARPAC (Agricultural Research Policy Advisory Committee). ARPAC was dominated by the influence of the state experiment station directors. The Joint Council was not.

This combination of events has created considerable tension within the agricultural research establishment. Charges are made of attempts by special federal interests to control agricultural research at both federal and state levels. Concern exists that the Joint Council is charged with responsibilities that it cannot be expected to adequately perform.

It is widely recognized that the strength of the agricultural research system is its decentralization and articulation of researchable problems by those most directly affected (Evenson, Waggoner and Ruttan). Increased central planning is not the answer. At the same time, a role does exist for a properly managed system of competitive grants in priority areas funded at a level that has the potential for yielding results.

To an important extent the problem is as much one of strategy to get the needed level and mix of support as it is one of directing research to priority areas. But one cannot disregard the fact that the two are interrelated. In order to justify a higher level of funding, relevance must be demonstrated.

Financial Base of the System

The agricultural research system is not less affluent in absolute terms than it was in 1970. In terms of dollars having constant purchasing power, from 1970 to 1977 public agricultural research expenditures increased 22 percent at the state level and 38 percent in USDA.

Reduced affluence of the system, if it exists, is in terms of the magnitude of the demands and problems confronting it. The following represents several dimensions of these increased demands:

1. While research problems used to be sufficiently simple that a professor with one or two gradute students could solve them, such is not the case today for most problems that are on the cutting edge of knowledge. Problems today are more complex. More often than not, their results depend on multidisciplinary solutions. For each scientific accomplishment the next has a tendency to become more difficult and costly.
2. The range of demand for food and agricultural research has increased. In the process new demands have come from the new agenda issues discussed previously. Others result from the more complex problems associated with solving ever-increasing world food needs.
3. Increased competition has developed between the use of research funds and the teaching responsibilities of the universities. Funds for teaching have failed to increase commensurate with student enrollment. Whereas research used to subsidize re-research, now research is increasingly subsidizing teaching.
4. An additional problem associated with the affluence of the research system is the more apparent decline in appropriations for extension activities. This decline, if continued over the long run, could reduce its effectiveness in both articulating research needs to scientists and disseminating the results of available research.

The Research Planning and Budget Process

The purpose of this section is to describe and critically analyze our perception of the food and agricultural research planning, budget and decision process. The emphasis in this description will be upon process, decisionmakers and performance.

The analysis attempts to cover all levels of the food and agricultural research system -- legislation, appropriations, planning, budgeting, administration and the decisions of individual research planning.

Nature of the Research Enterprise

Our discussion of the food and agricultural research enterprise emphasizes two central but interrelated issues:

1. How well the system is organized to influence the magnitude of the research program and the overall governmental setting within which research takes place;
2. The degree of central planning need in the system to assure that it is responsive to changes in research priorities given the fact that research resources are limited and the system must be accountable for what it does.

Either dimension of this task is not easy to accomplish.

McCall (p. 85) states the problem this way:

> "Thus, as it stands today, the public component of the agricultural research establishment is made up of a myriad of research organizations, funded from diverse sources, which through an elaborate maze of planning committees, advised by periodic conferences and studies, gives the impression of being a coordinated, planned research effort dedicated to the public good. At the same time, each research component (and the researchers in it) seeks to maintain independence to pursue its own interests."

--Magnitude of the Research Program.

In its most basic form three components are essential to a productive research enterprise:

1. The intellectual capacity (scientists) needed to do the research;
2. The research facilities, laboratories and land, computers and major equipment;
3. The inputs needed by the scientist to carry out the research program including scientific equipment, research personnel, chemicals, genetic material, computer time and so forth.

Each of these components costs money. The first two require a long-term, continuous base of funding support. The third requires short-term support in the form of spendable appropriations. Each of the three components is worthless without the other two.

Research decisions have four primary components: (1) planning including setting research priorities, (2) legislation and authorization, (3) budgeting and appropriations and (4) implementation. The planning and budget components can be visualized as having both short- and long-run dimensions (Figure 1).

The long-range dimensions refer to decisions that affect the overall size and intensity of the research effort. In a macro sense this involves setting long-range research priorities and budget goals, and obtaining needed legislative authorities.

The effectiveness of planning and budgeting in impacting research is dependent on the existence of funds of the magnitude and mix needed to implement. Research is inherently a long-run proposition. Maintaining its productivity requires long-run budget support consistent with needs and expectations. This longer term or "permanent" funding must be maintained if a flow of technological developments is to occur.

In the short run, macro planning decisions involve annual reviews of needs and response to identified clientele problems. Consistent with these needs, annual or biannual budgets are developed and justified through the appropriation process at federal and state levels.

--Research Undertaken.

In a micro sense, the long-run dimensions involve converting the priorities established in a macro context into planning for the development and training of the needed scientific manpower base, facilities and major equipment. Decisions also have to be made on changes in the direction of funds allocation among scientific disciplines.

Facilities must be constructed and maintained, new scientists must be continuously trained. Support must be provided for the existing and evolving base of scientific expertise.

Figure 1. Components of the Research Decision Process

	Program Magnitude Macro Aspects	Research Undertaken Micro Aspects	Funding Requirements
Long run	Planning	Planning	
	-- Setting research priorities	-- Developing scientific talent needs	-- Facility funding
	-- Establishing needed level of research effort	-- Developing needs for new and remodeled facilities and equipment	-- Scientific training
	Legislation and Authroization		
	-- Development of legislation base		
	-- Securing needed legislation		
	Budget	Budget	
	-- Developing long range budget goals	-- Decisions on direction for allocation and reallocation of funds	-- Research maintenance
Short run	Planning	Planning	
	-- Annual review of needs and response to clientele problems	-- Identification of departments and scientists in a position to respond to particular needs	-- Project funding
	Budget	Budget	
	-- Development and justification of budget proposals in appropriation process	-- Allocation of budget to individual departments and projects	-- Research grants
	-- Obtaining the desired language in the budget	-- Allocation of discretionary funds to deal with immediate problems	-- Special needs funding

Facilities must be expanded and modernized as the scientific base grows and new technological developments such as confinement facilities for cell culture are required. Continuous new and replacement scientist training is required. In other words, the long-term nature of research itself requires maintenance of the research budget on a long-term basis.

Short-run micro planning involves identification of departments and scientists that can respond to particular needs. Budgets are allocated to departments and projects consistent with these identified needs. A portion of the available funds is generally held back by the research administrators to deal with particular immediate problems as they arise.

In the short run the funding need is to support particular projects. These might include funds to conserve energy in agriculture, to increase the efficiency of energy production from biomass, to reduce rates of irrigation, to control the boll weevil, to eradicate the screw worm or to discover a means by which nitrogen-fixing qualities can be transferred to wheat. Incremental funding is required to conduct research on current problems in food and agriculture as seen by specific clientele groups as well as by the scientists themselves. The ability to respond to such needs is dependent both on the long-term funding base described previously and upon a short-term funding base which allows research administrators to supply added resources without disrupting the long-term research program. It is this flexibility which gives the food and agricultural research system its added margin of effectiveness.

Research Conflicts

Within the food and agricultural research system certain conflicts are apparent. Legislators and research administrators need to be aware of them. Administrators are, whether they realize it or not, continuously making decisions that influence the nature of these conflicts. Illustrations include:

1. Conflicts arise over the magnitude of the research program. Public funds are not unlimited at either the federal or state level. Legislators, government executives and budget analysts must make difficult choices among competing uses for tax dollars. Difficult choices must, therefore, be made among research priorities. The pie-in-the-sky wish lists of the research establishment must ultimately face up to the stark realities of a limited research budget. (Paarlberg, November 19, 1980).
2. Conflicts arise between state and federal agencies over the direction, nature of funding and content of the research program. The most visible of these conflicts include the degree, nature and control of federal planning; the appropriate balance between grant and formula funding; and the appropriate level of federal and state funding.
3. Conflicts arise between basic and applied research. Both are necessary to maximizing the productivity of the food and agricultural research system. Questions exist as to the appropriate mix of basic and applied as well as who ought to be responsible for each.
4. Conflicts arise between public and private research sectors. Public research competes with private research in the sense that results of public research are made widely available. In addition, the results of public research sometimes reveal that products of the private sector are not performing in the manner or to the degree suggested by the developer or merchandizer. Public economic research sometimes raises questions regarding the appropriateness of particular private sector trends in terms of the public interest. Public research, therefore, in addition to providing a product that is useful to private industry, provides a check on private industry. The principal beneficiaries of both are producers and consumers.
5. Conflicts arise between administrators who desire to direct research programs and scientists who conduct those programs. Scientists in the public sector desire a degree of academic freedom. This desire is stronger among university scientists than in government but exists in both.

In many respects this discussion of forces affecting food and agricultural research decisions is designed to clarify the nature of these conflicts with a goal of making suggestions that minimize them while fostering a continued high level of food and agricultural research productivity.

Research Planning

The need for planning and coordination of the food and agricultural research system is obvious (Figure 1). Planning must be done to determine the long- and short-run size of the budget needed to carry out the research mission as well as the scientific talent, facilities and equipment needed to implement. Planning must be done to clarify where specific areas of research responsibility lie, to communicate what is being done and what needs exist. The question, therefore, is not whether planning is needed but who should do what type of planning, how should the results of planning be translated into budget and how should planning and budget be translated into research.

Planning and related research information systems have been developed at both state, regional and federal levels. State and regional planning is heavily influenced by the federal planning system.

Planning within the food and agricultural research system has not come naturally. While every research administrator recognizes that the effect of plannning is to reduce one's latitude for decisionmaking -- particularly when other administrators are involved in the decision process. Scientist involvement has the potential for further reduction in an administrator's decision latitude. Yet effective planning requires the involvement of both scientists and administrators from across the food and agricultural research system.

The fact that research planning does not come naturally has meant that research planning initiatives have tended to be mandated -- by Congress itself. The Research and Marketing Act of 1946 mandated joint planning for regional research (Mahlstede). The USDA-NASULGC study titled "A National Program of Research for Agriculture" was mandated by congressional appropriations actions in 1965. Out of this grew the Current Research Information System (CRIS) and the Agricultural Research Planning Advisory Committee (ARPAC).

--ARPAC.

The ARPAC planning system, established in 1972, involved an extensive structure that included a National Planning Committee, 4 regional planning committees, and 50 task forces in each of the 4 regions organized on research topics. Designed as a "grass roots" structure, the ARPAC system produced priority research recommendations at the regional level and used to develop and support budget recommendations by USDA and NASULGC. McCalla has conservatively estimated that direct costs in operating the ARPAC system total near $2.5 million annually.

--Joint Council.

Despite the existence of the ARPAC planning system, the Congress in 1977 once again mandated a change in the food and agricultural research planning structure. The Food and Agriculture Act of 1977 created the Joint Council on Food and Agriculture and the National Research and Extension Users Advisory Board. The Joint Council was given the prime responsibility of fostering coordination of the performers of agricultural research, extension and teaching. The responsibilities of the Joint Council as specified in the legislation suggest the formation of a central planning agency for research, extension and teaching. These responsibilities include evaluation of program impacts, identification of high priority research, reviewing effectiveness of each federally supported research project, developing memoranda of understanding among the participants, establishing priorities, recommending responsibility for research and summarizing achievements. The Secretary is required to submit Joint Council recommendations to the Congress along with a five-year projection of national priority.

It is not surprising that the Joint Council has not, in its three years of existence, satisfied these objectives. In fact, the Joint Council only recently got its twenty-one-committee regional and national organizational structure developed (Mahlstede). Serious questions exist as to whether the Joint Council could ever effectively carry out the functions assigned to it! Even more serious questions exist as to whether, if it could carry out those assignments, the results would be desirable!

Castle in recent evaluation of the food and agricultural research planning system put it this way:

> "This (the present) system is a vast exercise in hypocrisy. All experienced administrators know that planning and coordination exercises are not worth much if control of budget and personnel resides elsewhere. If you believe as I and many others do, that decentralization has been and is a necessary characteristic of a productive system, the only thing worse than the present planning and coordination would be to give it control over budget and/or personnel. There are worse things than irrelevance; if the present planning and coordination really became relevant to budget and personnel the situation would be worse -- much, much worse."

--Users Advisory Board.

In addition to the Joint Council, the Food and Agricultural Act of 1977 created the Users Advisory Board. Its charge is to review the research and extension programs, policies, plans, goals and strategies to determine their adequacy and consistency with user needs. Recommendations on the adequacy and allocation of funding are also required of the Users Advisory Board. In addition, the Advisory Board is required to submit a report to the President and the Congress evaluating the President's proposed budget for food and agricultural sciences.

The Advisory Board's responsibilities are more realistic and attainable. However, serious questions exist about the relationship of its activities to those of the Joint Council in terms of development of an efficient and effective planning system.

--Duplication, Costs and Dissension.

While all of this is going on, the ARPAC system continues to operate. Thus three planning systems are operating at the same time. More correctly, two are attempting to get organized while the other is still operating. Castle estimates that the Joint Council and Advisory Board planning structure will cost three or four times the $2.5 billion estimated by McCalla for the ARPAC structure. In addition, normal planning in SEA, AR, ESS and at the state level goes on as usual.

In the meantime a great deal of dissension has developed within administrative segments of the system. For example, on July 31, 1980 the North Central Regional Experiment Station Directors Association voted unanimously to suspend participation in the Joint Council planning process. Their primary concern was a relative lack of state representation in the planning process. They expressed a desire to resume the ARPAC structure.

--Why?

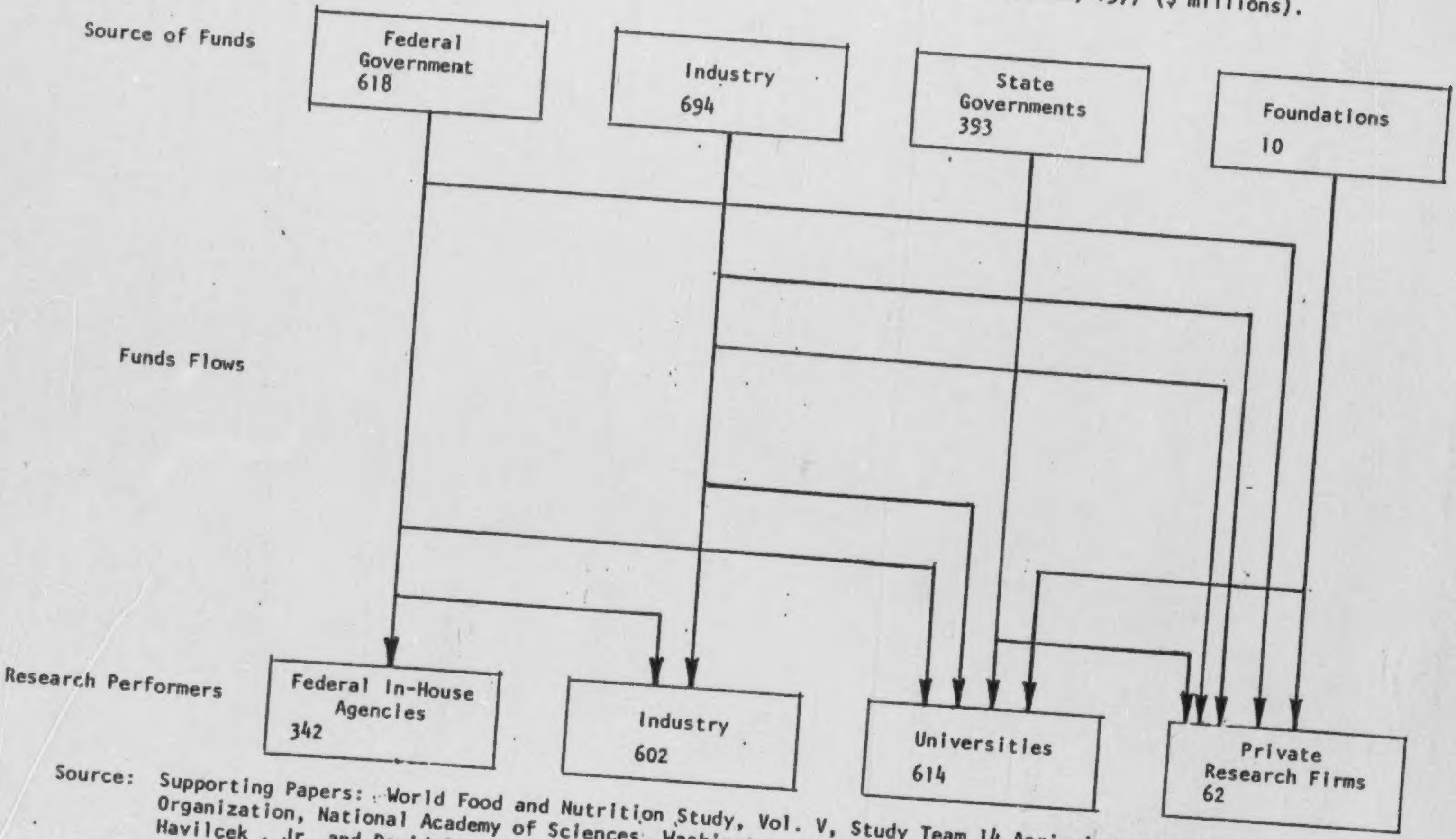
In light of the situation that exists today combined with the previous experiences in planning research, it is important to ask why Congress felt a need to make these changes. A number of reasons can be suggested:

1. Congress did not feel confident in the recommendations they were getting on appropriations. The President's budget recommendations were suspect as being manipulated by the agencies, the Secretary and OMB. ARPAC recommendations were suspect as being the product of the vested interests of the performers. No one was satisfied with the results.
2. Recognition existed in light of an increasingly tight world food situation that increased funding was going to be required. Congress desired to make sure new monies were spent in areas that had the greatest payoff -- the so-called high priority research areas.
3. Concern existed that the food and agricultural research system was not adjusting its research program to evolving clientele and needs. Areas such as consumers and nutrition were viewed as being overtly ignored.
4. The complexity of the research system led to the conclusion that it was out of control, duplicating research and unaccountable. Hearings tended to fortify rather than refute this conclusion. Administrators failed to clearly identify and explain priorities and how they were developed. Congress got the impression all they wanted was more money. In reality, the system was performing much better than this, but Congress was not convinced.
5. Experience with earmarking funds for specific research had not always worked. The impression existed that projects were simply being renamed and the research program did not change naturally.

Each and every one of these reasons was at least partially true. Restoring confidence in the system will require a recognition of this fact. It will also require that the food and agricultural research establishment become organized in a manner where they can have a more decisive impact upon and control over legislation enacted in their behalf.

Inquiry into the history of the 1977 farm bill Title XIV provisions suggests that the uncoordinated initiatives of a handful of well-intentioned individuals resulted in the development of a mandated, federally controlled, organizationally complex, research institution known as the Joint Council.

Figure 2. Research and development funds for the U.S. food research systems, 1977 ($ millions).


Source of Funds
Federal Government 618
Industry 694
State Governments 393
Foundations 10
Funds Flows
Research Performers
Federal In-House Agencies 342
Industry 602
Universities 614
Private Research Firms 62

Source: Supporting Papers: World Food and Nutrition Study, Vol. V, Study Team 14 Agricultural Research Organization, National Academy of Sciences, Washington, D.C., (1977), updated to 1977 from Joseph Havilcek, Jr. and David Otto, Historical Analysis of Investment in Food and Agricultural Research in the United States, OTA, Washington, D.C., (1980).

Budget Process

Appropriated funds are the lifeblood of the research enterprise. Publically supported food and agricultural research has traditionally been a federal-state cooperative responsibility.

Appropriations at the federal level are provided in two distinctly separate steps. First, authorizations for research are provided in legislation. In the case of food and agriculture, authorizations are provided by the agriculture committees of the House and Senate. Basic food and agriculture-related research and nutrition research may be authorized by other committees.

In 1977, the Congress authorized significant changes in agricultural research as part of the Food and Agriculture Act. These changes included provisions for competitive grants, equipment, facilities, the overall level of research funding as well as designated special needs funding. These authorizations build on previous basic authorization such as those contained in the Hatch Act.

As part of the 1977 farm bill, the research provisions resulted from a combination of special interest, executive and congressional concerns. These concerns were crystallized in a series of studies by agencies such as OTA, the National Academy of Science, the President's reorganization project and USDA. Increased funding authorizations reflected concerns about the adquacy of world food supplies, nutrition research, energy research, basic high priority research, research support in the 1890 land-grant colleges and Tuskegee Institute, small farm research and animal agricultural research.

Authorizations are translated into spendable research funds by the appropriations committees. Appropriations originate as part of the President's budget developed from agency requests, secretarial priorities and priorities established by the Office of Management and Budget on behalf of the President.

Appropriation hearings have traditionally been the main point of contact between the research agencies and the Congress. This fact accentuates the importance of clear, concise communication between the research agency and the appropriations committee in the hearing process. However, this communication process is limited by the fact that the agency is constrained in its supporting statement of needs and priorities by the magnitude of the budget approved by the President.

Recent years of efforts to control federal spending have resulted in the President's budget providing for considerably lower levels of research appropriations than the research community felt was needed. As a result, substantial lobbying efforts have been conducted by NASULGC, the Agricultural Research Institute (ARI), the agricultural experiment stations and other special interest clientele.

The state appropriation process differs from the federal process largely by the fact that in most states, food and agricultural research appropriations are part of the university budget. Thus, while USDA budget tradeoffs tend to be between budget items such as food stamps, commodity programs and research, at the state level the tradeoffs tend to be between different divisions of the university as well as among universities. In addition, at the state level there is always the question as to how much funds will be obtained by the experiment stations from the federal level. From 1966 to 1977 the federal share of support for food and agricultural research in the public sector declined from 38 percent to 30 percent while the private industry share remained constant at 5 percent.

--Flow of Funds.

An attempt to summarize the overall magnitude and flow of research funding is contained in Figure 2. The figure illustrates but oversimplifies the complexity of the food and agricultural research system in terms of:

1. The multiplicity of funding from federal, state, industry and foundation sources. The existence of multiple funding has two major impacts: (1) It provides increased opportunity for research institutions, projects and researchers to reach the critical mass required for support of their program and (2) it provides an opportunity for either the provider of funds or the recipient to play one researcher or research institution off against another (McCalla).
2. The multiplicity of research done in terms of federal in-house research, state experiment stations, other public and private universities and industry.

3. The existence of both direct and indirect funding routes. That is, funds follow directly from federal appropriations to in-house USDA research agencies such as AR and ESS. They flow indirectly from federal appropriations through CR or NSF to the universities.

It is also important to recognize that specific funding sources exist for the short- and long-run components of the research system discussed in Figure 1. Long-run sources of funding include the continuing basic appropriations to AR and ESS within USDA. It also includes the formula Hatch funds provided for the state agricultural experiment stations. In some state universities a long-term budget base of support is provided by various types of so-called permanent university funds as well as general basic support for the universities and their experiment stations.

In research the untied dollar has been a powerful institution. It, more than anything else, distinguishes food and agricultural research from either private research or other university research.

Federal funds to support the short-run research program include competitive grants, contracts and memorandums of agreement with specific research agencies including the USDA, NSF, NIH, DOT, DOE, as well as other federal agencies, state agencies and private industry. Havilcek and Otto's analysis suggest that in 1977 such funds accounted for less than 10 percent of total agricultural experiment station funding support. Great variation, however, exists among states and disciplines. Funds to support short-run research needs are also provided by discretionary portions of appropriations to both federal and state research agencies.

Effectiveness in Obtaining Funds

Substantial differences exist at the federal and state level as well as among states in both type of organization and effectiveness in obtaining the needed legislation, authorizations and budget.

In the states, greater reliance tends to be placed on grass roots support reflected through the farm organizations, cooperatives, proprietary farm supply and marketing firms and agricultural lenders. This is not to deny the significance of "power brokers" be they highly influential individuals or legislators. The combination of support from the grassroots and the "power brokers" is crucial in competition for agriculture's share of increasingly tight state budgets at a time when farm population represents a smaller proportion of the population.

Variation among states in the level of support for research is more than just a function of effectiveness in lobbying. Wide differences exists among states in the relative importance of agriculture in the states' economy, the size of the agricultural resource base, its productivity, as well as the size and prosperity of the states' population base. These differences, in many states have become a focal point of concern as the relative importance of federal support for research declines and competitive grants increased in significance.

Having said this, as a whole, individual states appear to be better off in organizing to marshall support for food and agricultural research than the overall food and agricultural research system has been at the federal level. A number of factors contribute to this observation:

1. An assumption may have existed that USDA would or could protect the interests of the research community. A similar assumption appears to have existed, from time to time, by farm organizations with respect to farm and food policy issues.
2. A lack of appreciation may have existed for the need to be continuously accountable for the relevance of the research program.
3. The research community may not have been adequately organized and/or sufficiently sophisticated politically to effectively tell its story.
4. A lack of appreciation may have existed for the complexity of the forces affecting research appropriations decisions such as the role of OMB.
5. A lack of emphasis may have been placed on obtaining "agriculture's share" of a shifting funding base for research. The increased relative importance of NSF and NIH in terms of total research are examples.
6. A recognition did not always exist of the need to unite across states with in-house USDA research to plead the case for increased funding.
7. Preoccupation may have existed with conflicts among research interests including the 1890's and non-land-grant institutions.

Many of these factors still, in varying degrees, undoubtedly exist today. Their impact is to reduce effectiveness in securing the needed level of support for the food and agricultural research. The sooner they are overcome, the better.

Research Decisions of Scientists

Despite the existence of elaborate administrative structures in both USDA and the universities, the major decisions on what research is to be undertaken are made by the research scientists. Scientists develop project proposals. These proposals are, as a rule, quite general. Within the proposals, scientists make the case for required level of support. Those scientists having a sound record of performance are in the best position to obtain support. Within the limits of the available budget, the scientist decides what specific research is to be undertaken.

Reality suggests that with increased complexity of research projects, research administrators are in a poor position to evaluate the relative merits of particular projects. Among scientists of comparable productivity, it is very difficult to predict which research holds the potential for a substantial knowledge breakthrough. Administrative decisions denying support for particular projects have the potential for being wrong more often than they are right. The further removed the administrator is from the project (the higher the level in the administrative bureaucracy) the greater the potential for being wrong. Thus, the greatest potential for administrators influencing research decisions is through hiring.

Because of the importance of the decisions of individual scientists to the total agricultural research program, it is fruitful to analyze the factors that influence their decisions on what research is to be undertaken. Little empirical research is known to the authors on this point. The following is, therefore, more in the realm of testable hypotheses and experience than established fact. The relative importance of the itemized factors undoubtedly varies from scientist to scientist and even among research institutions. Such differences will be discussed after the general motivating factors.

Decision-Influencing Factors

Motives influencing the research decisions of scientists may be grouped under four general headings -- intellectual curiosity, availability of funds, responsiveness to clientele and personal gain.

Intellectual Curiosity: Intellectual curiosity is research motivation in its pure form. It is the motive that led Gregor Mendel to discover the principles of heredity and caused Charles Darwin to persist in his studies until he formulated the theory of evolution. It is part of the motivation of every researcher worthy of the name. It involves a basic drive to push back the frontiers of knowledge, to discover why things work as they do and to solve problems no matter whose they are.

In a directed research program, it is often assumed that this vital spark can be ignited within the mind of a researcher who is detailed to a particular problem laid down by a planning group and financed by an appropriations committee. This assumption is only partly correct. More often than not, intellectual curiosity leads a scientist from one discovery to another -- each discovery point building on past findings. Administrative interruption of this process of discovering new knowledge can be costly. Likewise, the scientist is likely to be more productive working on a problem in which he or she has a direct interest. It might be that if the abbott of the monastery at Brno had directed Mendel to investigate plant nutrition instead of heredity even greater truth would have been discovered -- but it is not clear.

Availability of Funds: Research administrators often say that there are two real opportunities to influence research: (1) when you hire personnel and (2) when you allocate funds. Administrators of many highly successful agricultural research institutions have the philosophy that productivity is maximized if the majority of the administrative effort is spent selectively hiring top quality staff and securing the resources to support research they initiate. This philosophy is, in fact, the foundation of formula funding to the agricultural experiment stations. It is also the foundation of the peer review process in the competition grants program of NSF, NIH, and USDA.

Many examples record the meager results that flow from rearranging research priorities in the absence of employing new people or allocating new funds. In fact, reality suggests that both new people and new money are needed to give new research priorities a reasonable opportunity for success. If new funds are allocated to a priority project, but new people are not appointed, the likelihood exists that the new funds will be spread over ongoing projects. Some of these projects will be renamed to "conform with" the new priorities.

A substitution of grant funds for formula funds does not necessarily solve this problem. That is, in the face of reduced formula funding, grant money will likewise tend to be used to support ongoing research programs with formula funds being shifted to areas where grants are not available. It is also clear that new scientists appointed to a new mission without sufficient financial support nearly always result in failure.

Does this mean that the power to allocate, appropriate and grant is impotent in terms of changing priorities? Not necessarily, but it is overstated. It does mean that the most effective means of initiating change is through incremental funding. Competitive grants, to the extent that they are a net addition to the research program, are attractive to scientists. In addition to providing the scientist an added base of financial support, competitive grants give scientists, increased freedom to pursue their chosen field of research. Some experiment station administrators view this new-found freedom as undermining their control and increased federal meddling. The more enlightened administrators view it as an opportunity for increased support and excellence.

Responsiveness to Clientele: It has been noted previously that one of the strengths of the land-grant university system is the ability of clientele groups to articulate to the scientist their problems and needs. This occurs directly, through the Extension Service, through the classroom and through research administrators.

Responsiveness is not readily quantifiable. Perhaps the best way to find approximate answers is to examine the responsiveness of the system during what is now nearly a century since it began. The system shows responsiveness to organized agricultural clientele groups, whether these are farmers, agribusiness people or the established scientific disciplines within the agricultural scientific community. There is far less responsiveness to sectors of agriculture that are poorly organized -- part-time farmers, small farmers, hired labor and minority groups. There is fairly good response to analysis of social economics from the agricultural economics departments of the experiment stations. But there is very limited response to the sister social sciences including sociology, government and psychology, which are found elsewhere in the university.

There is limited focus on problems of the general public, perhaps in part because they are undifferentiated in terms of scientific disciplines and lack advocacy groups. Research in agriculture has done much better at the firm or farmer level than at the national or international level. Recent concern about "structure" reflects the belief that a tax-supported agricultural reresearch system owes the public more than to respond primarily to those clientele groups that are most affluent, most persuasive and best organized.

Responsiveness differs between basic and applied research. Basic researchers are, almost by definition, less responsive to traditional agricultural producer clientele. They are relatively more responsive to their peers, their scientific societies and the agribusiness firms that might directly utilize the results of their research.

Personal Gain: Promotion, salary, outside income and peer recognition are all important motivators for the researcher. They are generally recognized for their importance by research administrators.

These motivators are excellent means to an end, the end being discovery of new knowledge. For some researchers, personal gain has become not a means to an end, but an end in itself. The public is fairly quick to perceive this, and to discredit the individual, the system or both. Research administrators invite this criticism if they resort excessively to personal gain as a motive with which to energize their researchers.

While personal gain motives can be overemphasized, they can also be underemphasized. Salaries of scientists in the public sector must be competitive with the private sector. This does not mean they have to be equal. More risk and less freedom generally exist in private sector research. Taking into consideration this difference, unless salaries are competitive, danger exists that the top public sector scientists will continuously be attracted into the private sector.

Retaining the top scientists within the public sector requires differentiation in salary on the basis of performance. Restrictions on budgets tend to compress salaries. This happens when research administrators attempt to give every employee salary increases that approach changes in the cost of living. It also happens when appropriations contain provisions mandating minimum percentage salary increases for all staff. Wage and price controls have, however, had a similar effect in the private sector.

Differences exist among universities and USDA agencies' ability to reward top quality scientists. Substantial and increasing differences exist among universities in the resources available to attract scientific talent. These differences result from a combination of factors such as the state's population, income, resource base and tax structure. It is also affected by the federal system of allocating research dollars. For example, increased emphasis on competitive grants allocated strictly on the basis of proposal and scientific qualities will tend to further concentrate research in those universities that have had the research dollars needed to attract top quality basic scientists.

Other important differences exist in the ability to reward scientific talent. AR has successfully obtained civil service clearance to increase the G.S. ratings of top scientists without giving them administrative responsibility. ESS has not been successful in accomplishing this. As a result, top scientists in ESS tend to be attracted into administration as a condition for advancement. Such a policy is counter-productive. In addition, the ability of USDA scientists to earn outside income is more restricted than that of the university scientists -- although considerable variation exists among universities as well as in consulting policies.

Federal-State Differencies

Particular differences likely exist between USDA scientists including both AR and ESS and university scientists. Traditionally the USDA research program has been more administratively directed. It is also sometimes suggested that USDA research is more macro, that it emphasizes national problems and includes a higher proportion of basic research. Such an assertion appears to be increasingly questionable as an increasing quantity of USDA research results from service to the Secretary and agencies of USDA while competitive grants bolster university basic research.

A higher degree of research program direction by USDA administrators suggests that scientists in the federal system might have different motives than those in the universities. Scientists that desire greater freedom -- less direction -- tend to be attracted to the universities. Those who desire to teach as well as conduct research are attracted to the universities.

Differences also likely exist between the motives of agricultural scientists working in the USDA land-grant complex compared with those that are employed by non-land-grant universities or that work in departments of land-grant universities that are not part of the agricultural experiment station. There, scientists are generally more involved in basic research and more dependent on grant funds. They likely place a higher value on intellectual curiosity and are likely less directly responsive to traditional agricultural clientele. Their value as researchers to agriculture and the public is, however, fully as important.

Substantial differences in research motivations may exist between AR and ESS as well as over time. AR research is generally conceded to have become more applied since research decisions were regionalized in 1972. This regionalization resulted in greater contact with and articulation of research needs by interested clientele to both scientists and administrators. At the same time, it is increasingly suggested that the 1972 reorganization undermined the highly specialized and talented expertise that had traditionally existed in USDA. That is, regionalization dispersed the concentration of specialized talent that existed in USDA. This specialized talent had become a focal point and source of information on specific research topics (Moseman et al.).

Over time the ESS research program has become more highly centralized with fewer field scientists. Concurrently, it has become more oriented toward macro economic problems confronting the Secretary of Agriculture and the Congress. Over time, this trend has resulted in increased criticism that ESS has become a "brush fire" research agency lacking the longer term basic research needed to better answer future economic problems. While such criticism may overstate the case, it is clear that both the Secretary of Agriculture and the Congress have become reliant on ESS for policy analsyes without commensurate increases in appropriations, requiring policy-oriented shifts in the use of available scientific resources.

Public policy issues also appear to be consuming an increasing share of the research manpower in AR. Many of these accelerated public policy research demands on AR resources come from new agenda concerns such as environment, gasohol, food safety and nutrition. While such changes in program direction may be needed, they tend to be disruptive to ongoing longer term research.

Legitimate danger exists that USDA research has or will become predominantly "brush fire" with a de-emphasis on basic and longer term applied research.

Evaluation, Conclusions and Recommendations

Despite its complexity, the food and agricultural research system operating in a relatively free market agricultural setting has an enviable record of success. This success has been accomplished in a decentralized research setting where scientists in proximity to their agricultural clientele make the critical decisions on what research is to be done. Aside from clientele contact, administrators discretionary incremental research funds, competitive grants and normal attrition have been the primary means of modifying the mix of research that has been undertaken.

As both fear and evidence of an increasingly tight world food supply-demand balance increase, as pressures to cut federal spending mount and as the size and complexity of the food and agricultural research establishment grows, Congress as well as state legislators have become increasingly concerned about the performance of the food and agricultural research system. Incentives exist for increased planning, increased accountability and greater control over what research is to be done.

Organization of the Research Establishment

The food and agricultural research establishment has not effectively articulated to its legislators either the nature of its research mission, its priorities or the means by which its research program is carried out. It has also developed communications problems with top USDA and OMB decisionmakers.

Reality suggests that the food and agricultural research system has not been sufficiently well organized at the federal level to communicate either the magnitude of research needs or developed the needed mechanisms for communicating those needs to the Congress. This lack of organization is reflected in both agriculture's inability to capture its share of federal research appropriations. It is also reflected in the passage of farm bill provisions by the Congress which the research establishment later found that it could not live with.

Title XIV Joint Council Amendment

The solution to the problems that exist is not increased planning and control by the federal government. At this point in time, before further resources are wasted, a drastic reappraisal and subsequent amendment to the Joint Council structure and responsibilities provided for by the Food and Agricultural Act of 1977 should be undertaken. We likewise endorse the recommendation by Castle that this be done through a joint meeting between representatives of the research establishment, the Secretary of Agriculture for the Reagan administration, OMB representatives and the leaders of the House and Senate agriculture and appropriations committees.

As a point of departure for discussion in this meeting we suggest the following:

1. That the need for and merits of a decentralized research system be recognized at the outset.
2. That accountability must exist at both federal and state levels for how money is spent and the results of the research effort.
3. That effective research planning requires consideration of both short- and long-run needs of agriculture and the general public.
4. That long-term research planning covering a period of five years or more can best be accomplished on an intensive comprehensive study involving research administrators, scientists and users. Such a study should evaluate what is being done, existing priorities, needed new research opportunities, and develop a new set of research priorities and recommendations for research funding over the next eight years.

   The methods used in the National Academy of Science World Food and Nutrition study provides an excellent illustration. Such an intensive evaluation of the United States Food and Agricultural Research System might legitimately be undertaken every eight years with a final report delivery date of December 1 of the year of each presidential election. This timing would concur with both the installment of a new administration and the enactment of a new farm bill

   Such a planning system should not be institutionalized in terms of the people involved. A cross-section of scientists and research administrators should be included. This _ad hoc_ feature is viewed as being critical to success in long-range infusion of new ideas.

5. Short-range planning should be done regularly by each research entity in conjunction with budget preparation. That is, to bridge the gap between priorities and budget, research units should give special attention to how the proposed budget fits into the achievement of the goals established in the priorities identified in the eight-year plan.

   Flexibility should exist for individual research units to emphasize those designated priorities that fit most closely with their agricultural situation. For example, since about half of Texas farm income comes from beef, priorities relating to animal agriculture would logically receive a higher degree of emphasis in Texas.

   Accountability to the federal government in this context should relate to federal dollars contributed. It is, however, clear that such a system of long-term priority establishment and short-term budget planning would also make sense at the state level.
6. Using this concept, the responsibility of the Joint Council would be modified to place emphasis on: (1) supervision of the planning process, (2) providing a forum for communication and (3) providing interim evaluation of planning goals. To be specific, the Joint Council would make arrangements for recruiting a director, deputy director, and detailing staff to the long-range planning process. It would also assist in identifying and recruiting scientists and administrators to be part of the long-range planning process. It would be the focal point monitoring and evaluating the extent to which the research system is meeting the priorities and objectives specified in the long-range plan. It would also provide an interim four-year evaluation of priorities in light of conditions in agriculture.

   This specification of responsibilities for the Joint Council would permit a much more simplified structure than is currently anticipated. While regional committees may still be desirable, the designation of separate structures for teaching, research and extension is questionable. In addition, the number of meetings required could be substantially reduced and meeting time could be devoted to periods of greatest need.
7. Established priorities should serve as a basis for authorization and budget hearings with the Congress. Hearings should reflect accomplishments and changes in orientation that result from the planning process.
8. The whole process should be conducted on a continous rolling basis that generates reports of past accomplishments, support for current budget hearings and periodic reports on longer term priority needs in terms of budget planning and authorizations.

Competitive Grants

This organizational proposal is not a rejection of the bulk of the constructive initiatives taken in the Food and Agriculture Act of 1977. It, for example, would not change the positive initiatives taken to increase support for competitive grant funding of high priority research and open the grant process to non-land-grant universities. It is, however, our conclusion that grants should be viewed as incremental funding, not a substitute for formula funds. Initiatives should also be taken to assure that individual projects are funded at a level that provides the potential for research results.

Responsibility for Basic and Applied Research

The 1972 reorganization of ARS, increased AR responsibilities for serving the research needs of USDA action agencies, integration of the non-land-grant universities into the food and agricultural research establishment of the competitive grants program signals a change in the mix and responsibility for basic research.

At one time ARS and ERS may have been considered the place where most of the basic research should be done. Such is no longer the case.

Many experiment station research units are sufficiently large and well staffed to efficiently and effectively rely on for basic research. Several universities outside the land grant system have comparable centers of basic scientific knowledge.

The point is that food and agricultural research, like any other research should be done where the expertise exists. To stereotype any research agency as basic or applied would be a serious mistake.

Distribution of Resources

Recommendations such as those made above should not be entered into blindly without recognition of their distributional effects. Over time as the relative importance of federal funding research has declined, greater disparity in the availability of research resources among states has become evident. Thus the base of support for agricultural research in states with declining farm population has likewise declined. Such universities likewise have increased difficulty obtaining competitive grants.

In addition, increased reliance on state support makes the research system more vulnerable to local economic conditions that result in sharp budget reduction. Such reductions seriously undermine the long-term nature of the research process.

Special attention needs to be given to these problems. Options such as changes in the formula for fund allocation, the establishment of a special contingency fund to deal with the effects of economic disturbances, and increased regional cooperation and specialization among states needs to be evaluated. A special study of this problem under the auspices of the Joint Council would be appropriate.

Organizing for Support

The productivity of the food and agricultural research system is beyond question. Relatively speaking problems of responsiveness are minor. Yet rewards in terms of continued support are not automatic. Competition for tax dollars is keen and likely to become even more intense.

The story will not tell itself. The system must be accountable, have spokespersons, be politically astute and well organized. Problems are particularly apparent at the federal level. State, regional and federal-state conflicts exist.

State research administrators vie for power and spokesperson status at the federal level. A lack of willingness to compromise and subsequent regimentation is evident.

The agricultural establishment is not sufficiently utilized to plead the case for the research community. They have not been sufficiently well informed by the research community to plead the case. In some cases, farm organizations have themselves been suspicious of the extent to which the system is serving their interest. This fact was evident in farm organization response to OTA inquiries in this study.

While this problem has not been neglected, it needs more attention. A special task force covering a cross-section of those involved in and affected by research should address this problem.

Extension Part of the System

Virtually all of the discussion in this paper has been devoted to research. It would be a serious mistake to, by omission, ignore the importance of extension of research results.

It is interesting to note that while the research budget has not increased commensurate with the magnitude of the problem, the federal extension budget has increased at less than half of the rate of research. The effect of this trend, if continued over a substantial time period, is to undermine the important articulation and education dimension of the research, teaching and extension triad.

Having said this, it is all too often assumed that administrative, legislative and budget methods applied to research also apply to extension. It is important to recognize that administratively, Cooperative Research and Extension Service may have more in common than Agricultural Research and Cooperative Research.

The Real Problem

The problems internal to the food and agricultural research system are small relative to those that must be solved by it to adequately feed and clothe the people of the world. Identifying and solving those bigger problems must be the focus of our attention. Those problems are solved in the laboratory -- not in Washington or the statehouses. The only thing Washington and the statehouses can do is to create an environment which gives scientists the greatest opportunity to solve the problems of food and agriculture. We believe the insights and recommendations of this report would be a step in that direction.

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Commissioned Paper III

THE ROLES OF THE JOINT COUNCIL ON FOOD AND AGRICULTURAL SCIENCES AND THE NATIONAL AGRICULTURAL RESEARCH AND EXTENSION USERS ADVISORY BOARD IN COORDINATING RESEARCH AND DETERMINING RESEARCH PRIORITIES

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Office of Technology Assessment

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Summary

Public Law 95-113 referred to as the "Food and Agriculture Act of 1977" is composed of 20 titles, including Title XIV, the National Agricultural Research, Extension and Teaching Policy Act. This title establishes the U.S. Department of Agriculture as the lead agency in the Federal Government for the food and agricultural sciences and identifies research, teaching and extension as distinct missions of the agency. The legislation authorizes the Secretary of Agriculture to establish the Joint Council on Food and Agricultural Sciences (Joint Council) and the National Agricultural Research and Extension Users Advisory Board (Users Advisory Board) to aid in improving planning and coordination between the Department of Agriculture, other federal agencies, land-grant colleges and universities, state agricultural experiment stations, state cooperative extension services, colleges and universities, and other public and private institutions, producers and representatives of the food and agricultural sciences.

The development of an effective research planning structure had its beginning with the preparation of a study entitled "A National Program of Research for Agriculture." This report, requested by the Senate Appropriations Committee, was published in 1967 and recommended the establishment of an additional Assistant Secretary in the Department of Agriculture for Science and Education, the development of a better mechanism for joint planning, the development of a system to identify research projects and report results, the broadening of the USDA grants and contract programs, closer research-extension collaboration, joint state-federal advisory committees and similar changes to make the system more effective. The passage of Public Law 95-113 has brought into focus the majority of these recommendations, together with other innovative management schemes.

With the establishment of the Joint Council and Users Advisory Board, there has been some lag in the implementation of the intent of the basic legislation as new alliances have been created, roles identified, procedures detailed and responses made to specific issues. As with the evolutionary process of any expanded management system based on mutual trust and the modification of time-proven operating procedures, a certain adjustment period was necessary to develop new strategies and approaches. In order to accommodate these adjustments, it is recommended that the authorization of the title be extended for a period of five years.

Specific recommendations to foster more effective research, extension and instruction in the food and agricultural sciences, including but not limited to productivity, the development of new food, fiber and energy sources, conservation of this country's natural resource base, the promotion of the health and well being of people, human nutrition and international food and agriculture programs are as follows:

1. More timely and widespread distribution of reports and recommendations emanating from the Joint Council and Users Advisory Board.

2. Recognition that regional planning and coordination networks do exist and that use should be made to involve these entities in the development of more effective priority setting systems.

3. Establishment of closer liaison between the Joint Council and Users Advisory Board planning and coordination mechanisms over the range of agricultural subjects, inclusive, but not limited to animal health and disease research and aquaculture.

In order to improve the management and operational functions of the Joint Council and Users Advisory Board, it is further recommended that:

1. As authorized in the original legislation, six professional staff members should be selected for full-time service to these bodies. One of these individuals should be selected as Executive Director to jointly serve the Council and Board under the supervision of the Co-Chairman/Chairman of the respective organizations.

2. In order to take greater advantage of the expertise that exists throughout the food and agricultural system in the United States, it is recommended that regional membership on the Joint Council be increased by at least five members from those entities which have a major responsibility for research, extension and higher education.

3. Strengthen commodity representation in the Users Advisory Board by increasing membership of representatives of producers of agricultural, forest products and aquacultural commodities by five.

4. Amend authorization for appropriating such funds as may be reasonable for carrying out the provisions of Sections 1412(a), (b) and (c) and Section 1413 (b) relative to the operation of the Joint Council and Users Advisory Board.

Introduction

Public Law 95-113, an Act passed by the 95th Congress "to provide price and income protection for farmers and assure consumers of an abundance of food and fiber at reasonable prices and for other purposes" became law on September 29, 1977. This legislation, referred to as the "Food and Agricultural Act of 1977" is composed of 20 separate titles and 192 sections relating to the authority and procedural details for the administration of those titles. One of these, Title XIV, the National Agricultural Research, Extension and Teaching Policy Act of 1977, establishes the Department of Agriculture as the lead agency in the federal government for the food and agricultural sciences, and identifies agricultural research, extension and teaching as distinct missions of the department. Thus the basic credos established by earlier legislative acts that founded the Land Grant Universities, established the agricultural experiment stations, and set in place the cooperative extension service, were reaffirmed. In addition, the state level partnership among three functional areas became part of the Federal structure for the first time. Until 1977, the Department of Agriculture did not include teaching as an equal partner with research and extension.

The Food and Agricultural Act of 1977

In developing the Food and Agriculture Act, Congress recognized the federal government's important historical role in funding agricultural programs and further strengthened the authority for continuance of that role. Congress noted the need for 1) closer liaison among all research programs, 2) increased sensitivity to the effect of technology on people, 3) development of more efficient production methods for food, feed and fiber, 4) improved marketing technology, 5) replenishment of our basic knowledge pool, 6) development of new ways to conserve natural resources and 7) production methods suitable to a time of increasing energy constraints. They also identified specific new federal initiatives to meet needs stemming from changes in agricultural production and world food needs.

This new authority placed particular emphasis on coordination among all partners in agricultural research and education. To this end, the Secretary of Agriculture was given the responsibility for coordinating programs within the Department of Agriculture and with other federal agencies and state-federal cooperative programs. The Secretary was requested to establish ongoing mechanisms to identify research needs, foster cooperation and information exchange and make annual reports on actions taken to support the recommendations of the Advisory Board. The Congress authorized the Secretary to establish two new committees, the Joint Council on Food and Agricultural Sciences and the National Agricultural Research and Extension Users Advisory Board, to aid in the accomplishment of these objectives. Congress made the Secretary responsible for consulting these two groups concerning formulation of basic policies, goals, and priorities.

The Joint Council on Food and Agricultural Sciences

Section 1407 of Title XIV gave the Secretary of Agriculture authority to appoint a 25-member Joint Council on Food and Agricultural Sciences. The Council was to include the traditional research and extension partners as well as representatives from other public and private institutions and constituencies with an interest in (and potential for) contributing to national policy formulation.

Background for Coordination Efforts. The Council has perceived its primary responsibility under PL 95-113 as improving the planning and coordination of research, extension and teaching activities of participants in the USDA's food and agricultural system. Such federally initiated coordination dates back to the early 1900's and the USDA-operated field stations, to early, nationwide disease- and insect-control programs, to federal promotion of corn breeding and beef cattle breeding, and to soil and water conservation efforts especially in the Great Plains. In 1946, the Research and Marketing Act mandated joint planning for regional research.

The long-range research planning system, in place when the current legislative act became law, had its beginning in 1965, when the Senate Appropriations Committee directed the USDA and state agricultural experiment stations to develop a long-range research needs report. One recommendation in the resulting study, "A National Program of Research for Agriculture," was the establishment of a method by which researchers could monitor each year's research results and track related manpower and financial inputs. The Current Research Information System (CRIS) catalogs abbreviated annual progress reports on all publicly supported research projects in the food and agricultural sciences. The computerized system allows access to the information all across the nation. Studies are catalogued by RPA's (Research Problem Areas) making it easier to quantify research by area.

In response to the 1965 directive, ARPAC, the Agricultural Research Policy Advisory Committee, and a structure of national and regional planning committees evolved. The goals adopted by ARPAC in 1974 included:

1. maximizing use of scientists, facilities and equipment
2. avoiding unnecessary duplication
3. minimizing the danger of important research needs being overlooked
4. avoiding fragmented efforts
5. directing resources to high priority objectives
6. identifying emerging problems

ARPAC was central to the development of an overall plan to maximize return on resources invested in food and agricultural sciences. Implementing the plan was left largely to administrators of federal agencies and state experiment stations. In moving from the planning mode to action programs, new needs for communication and joint action became obvious. Plans developed by ARPAC overlapped with plans made by state institutions and other federal agencies as well as by other organizations involved in food and agricultural research. The specialized interests of scientists, administrators, research users and consumers, and the legislative and jurisdictional pressures growing out of these interests, further complicated implementation. Such complexity is inevitable in a democratic system, and society profits from a flexible, responsive, diverse scientific system. However, it became apparent that the more research and social needs interlace, the more important it is to coordinate the planning activity. PL 95-113 recognized this need and called for a change in the manner in which planning was achieved.

The Council's First Two Years: The Council held its first meeting in April, 1978. The Assistant Secretary of Agriculture, responsible for teaching, research and extension, was to co-chair the committee with a non-federal Council member to be elected by the Council.

The initial action by the Council was the development of organizational details to address the various studies and functions, identified by the legislation. An executive committee was established to handle interim business between quarterly meetings. The Deputy Director of Joint Planning and Evaluation was designated to serve as the Executive Director to both committees, the Joint Council and the Users Advisory Board.

Dr. Anson Bertrand, Director of Science and Education, became a Council member in July, 1979, and in August, following reorganization of the SEA, became co-chairman of the Council. (Revised No. 1938 memorandum from the Secretary of Agriculture designated the Director of Science and Education as co-chair of the Joint Council.)

The Council's planning and coordination structure has evolved over a two-year period. Considerable debate attended these efforts to broaden participation in planning and coordination and create a representative new structure. In the structure finally adopted by the Council (Appendix 1, page 17), each of the four regions has three committees, one for teaching, one for research, one for extension. The three fall under a regional council. The structure also gathers functional areas under a single national council. That is, all four regional research committees operate under a national research committee, etc. In developing this structure there was a consensus that research scientists should be included in the planning and coordinating processes.

As the structure evolved, the Council issued a number of papers (see Appendix 1) addressing questions of concern to the diverse constituency represented within the committee structure. These included papers on:

- Joint Council planning and coordination, role, objectives, and definitions,
- current planning and coordination efforts,

- internal linkages and operations within the joint council planning and coordination structure,
- external linkages between the Joint Council and others in the Food and Agricultural Sciences, and Education system,
- resources for the Council planning and coordination activities.

From the beginning, the Council viewed the Users Advisory Board as its main link with users of science and technology. The Council regarded this link as indispensable to responsible planning.

Once the present structure was agreed upon, a Steering Committee developed procedural guidelines for handling information through the network of committees. The four ad hoc regional councils had these policies in hand by summer, 1979, before their organizational meetings. Permanent councils for each region are now in place.

While the Council set up the present organizational structure, interim national and regional planning committees and the Interim National Planning Committee carried out the Council's assigned tasks. The interim committees were, essentially, a continuation of the system developed under ARPAC, the joint effort between the USDA and the National Association of State Universities and Land Grant Colleges.

The interim committee's report was submitted to the Council in July, 1980. It summarized the 1979-84 food and agriculture research plans of all agencies and institutions in the partnership. The report was based on information from CRIS.

Another planning committee, the ad hoc committee on the Five-Year Plan, was charged with recommending research priorities for the early 1980s. Its report, "Areas of Emphasis in the Food and Agricultural Sciences for the early 1980s," was published in March, 1980.

In a sense, all Joint Council activities lead to priority setting. Recommended priorities form the basis for the Council's annual report. They also play a significant role in 1) development of the Department of Agriculture's budget requests; 2) development and maintenance of an information network; 3) establishment of competitive and special grants programs; 4) development of a faculty grants program; 5) design of a training grants program to strengthen undergraduate and graduate education; and 6) guiding visionary research thrusts.

During the past two years, the Council's struggle to develop a workable planning structure sometimes evoked images of over-organization or tenuous communication links. In contrast ARPAC, a product of many years of development, sometimes seemed a better planning structure.

The Council faced a problem ARPAC had not encountered. In attempting to make teaching, extension and research equal partners in research planning, the Council sought for a program structure common to the three functions. Instead they found that each function had a unique structure, developed to suit its needs. When the Council indentified an area for which coordination across the three functions should have high priority, these structures did not lend themselves to examination of existing interrelationships or establishment of new ones.

Perceived Accomplishments of the Joint Council: The Council counts among its successes:

- its function as a forum for interchange of information and ideas among and within its committees;
- its broadening of participation in research planning to exploit the diversity of the U.S. food and agricultural science and education community;
- its analyses of the economic, environmental and social impact of activities in research, teaching and extension;
- its identification of high priority research areas and its review of the effectiveness of the system in addressing these needs.

National Agricultural Research and Extension Users Advisory Board

The 21 Users Advisory Board members appointed by the Secretary of Agriculture are responsible for representing the divergent opinions of users and forming a composite picture of users' needs and priorities. They are chosen for their potential to offer opinions independent of political considerations that might inhibit federal employees or organizational representatives.

Some members come from the food and agricultural sectors of the economy; others are consumers rather than producers.

The board is mandated

- to review the Department of Agriculture's policies, plans and goals and to review related programs of other federal and state departments and agencies, colleges and universities;
- to assess the extent of agricultural research and extension conducted by private foundations and businesses and examine relationships between private and public programs;
- to make recommendations on policies, priorities, and strategies for research and extension;
- to assess distribution of resources and allocation of funds for research and extension;
- to deliver its message to the highest levels of government (the President, Congress and the Secretary of Agriculture).

The Board's assessments and recommendations form an annual report that goes to the Secretary of Agriculture, the Subcommittee on Food and Renewable Resources and the Joint Council. The Board is also responsible for appraising the President's proposed budget for food and agricultural sciences and the Secretary of Agriculture's recommendations as outlined in the Department of Agriculture's annual report. The Board's budget report, due by March 1 each year, goes to the President, the House Committee on Agriculture, the Senate Committee on Agriculture, Nutrition, and Forestry, and the House and Senate Committees on appropriations. Thus, the Board fulfills what it regards as its primary mission - delivering a message that might not otherwise reach government decision makers.

The UAB's Method of Establishing Research Priorities: In a letter of transmittal accompanying the Board's first report, October, 1979, the Chairman Ralph Abascal noted that the report represented research and extension users "collected opinions" on priorities for allocation of resources and responsibilities among research and extension programs with an emphasis on "those areas where we find program results insufficient from the users' view, regardless of current levels of work."

To develop these collective opinions, the Board first identified its mutually held concerns and investigated current funding and activity in each. This resulted in a preliminary list of nine priority areas. Next, the Board received an inventory of research and extension activity in each of the nine areas (this was prepared by the USDA's Science and Education Administration). The Board solicited more opinions on priorities, holding a field meeting and a public forum to obtain direct input from other users. Following these meetings the Board modified its original list to develop a statement of Board opinion. A second report, published six months later, was developed using similar procedures.

Priorities recommended by the Users Advisory Board are examined by the Council, and the UAB in turn reviews the Joint Council's recommendations. In the end, the two may agree on one set of priorities but they are not obligated to do so.

Evaluation of the Joint Council and the Users Advisory Board

Concern about the new planning structure prompted one of the four regional Agricultural Experiment Station Directors' Associations to vote unanimously to suspend any participation in the regional and national planning process. The organization withdrew because of

- disapproval of the membership and size of the National Research Planning Committee (NRPC).
- lack of direct utilization in the development of the research budget within USDA of research priorities established in the state planning process
- lack of understanding of the role and function and probable duplication of effort by the regional planning councils assuming that the regional research, extension, and teaching planning committees function properly and report directly to their respective national planning committees.

These concerns were expressed at the end of the extended period required to develop a hybrid structure, a time of struggle that evoked memories of the evolutionary planning process developed under ARPAC.

In assessing changes in the enabling legislation that resulted in formation of the Users Advisory Board and the Joint Council, it is important to keep in mind the planning system that existed prior to 1977. That system was the result of a relationship that existed between the USDA and State Agricultural Experiment Stations for a period of 90 years. As the Hatch Act and attendant legislative actions refined the original intent of Congress, the federal-state relationship evolved a planning and coordinating mechanism to meet both the intent and spirit of the law. The most recent effort to expand the planning system for the agricultural research and educational system may have caused grass-roots activities to lose visibility and a voice. Continuing limitations in resources made available to undertake new thrusts identified by the Users Advisory Board and the Joint Council exacerbate dissatisfaction with the system.

Recent actions by the Joint Council on Food and Agricultural Sciences (Appendix 2) underscores the complications of establishing a planning and coordination structure that complies with the enabling legislation and elicits broad support by the three functional areas in the science and education community. In this proposal, the four Regional Councils will be charged with the evaluation of regional concerns that cut across research, higher education and extension programs. As the result of the conduct of selected planning and coordinating activities, specific recommendations for improving and strengthening the federal-state partnership in the food and agricultural sciences would be communicated to the national functional committees. These national committees in research, extension and higher education in turn, would be charged with the development of a national program for each area, monitor progress, recommend changes to improve coordination, assist the Joint Council in the development of the five-year priority projections and analyze the impact of science and education policy on progress toward established goals.

The fact that the Secretary of Agriculture has been charged with the coordination of all agricultural research, extension and higher educational activities conducted under and financed by the Department of Agriculture, makes the oversight and planning activities of the Joint Council and Users Advisory Board critical. The linkages between the grass roots regional functional committees of the Joint Council which now are optional, places greater reliance upon the mechanisms used by the Regional Councils to obtain information basic to national program development. In addition, the importance of geographic representation of those engaged in research, extension and instruction, as well as producers of agricultural, forestry and aquacultural products, becomes obvious. In developing the membership from the various categories of representatives identified for service on both the Joint Council and Users Advisory Board, continuity of function is another important consideration in sequencing appointments. Not only is the importance of continuity of committee membership instrumental to success of these two major Title XIV committees, but their purposes are best served by the employment of highly qualified staff members of the caliber who have served in the Executive Secretary slots. The problems brought about by the imposed hiring freeze, manpower ceilings and the drawn-out process of employment, have done little to facilitate the work of the Joint Council, in particular.

Suggested Changes for Making the Joint Council and Users Advisory Board More Effective

It has become abundantly clear that while the basic mission of agricultural research has not changed significantly in the three-and-a-half decades since World War II, public concern about the innovations that have resulted from postwar technologies, together with the effect of many of these on human health and the environment, has. Coupled by the realization that the world's natural resource base is not infinite, the current mood of the country has focused on conservation in the short run and the development of new technologies for the long term. Agriculture now finds itself caught in the limelight of a continuing expose of self-analysis, peer review and untested alternative strategies for overhauling the present system of planning, priority setting, financing, technology application, production, and manpower training. The challenge for the decision makers, the public, and the expanded system is to map a strategy that builds on the past and one that will result in continued progress toward maintaining this country's productive capacity, improving the environment, and making people better off.

Dr. Emery Castle, speaking before the National Association of State Universities and Land Grant Colleges, advanced a five-point program* to enhance the credibility of agricultural education and research. Primacy was given to the overhaul of the existing system of national planning and coordination, which Castle described as a "vast exercise in hyprocrisy", since control of budget and personnel resides elsewhere. He further concluded that a much simpler system than the one proposed, undoubtedly would serve the political needs just as well. It was suggested that any new apporach to planning and coordination be based on three fundamental principles, namely, 1) that it be a decentralized and open system, 2) that those involved be amenable to a vigorous review process, and 3) that the agricultural research and educational system should cooperate in a program to assess its productivity in terms of growth, equity and security.

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* Agricultural Education and Research: Academic Crown Jewels or Country Cousin? Kellogg Foundation Lecture. November 18, 1980. 38 pages.

Castle is correct in his observation that a less complicated system for planning and coordination than is now on the verge of being set in place, will eventually evolve. If nothing else, the cost of aggregating the large numbers of representatives in regular regional meetings of the functional parts, and then integrating these into representative national bodies to dialog in an overall coucil, will require sizable inputs from participating constituents, plus significant commitments in time from individuals who are serving on these committees. If nothing else, those who are chosen to serve in these roles from the non-tradional partners may well lose interest because of the dual costs without apparent benefits or assistance to defray incurred expenses.

In observing the gyrations which have gone into attempts to build a better "mousetrap" for the Department of Agriculture and the SAES partnership, and in spite of all the untested advice handed down by self-proclaimed historians, change agents and critics of mechanical harvesters, significant changes from that which has produced an abundance of food, feed and fiber, have been few. This is not to say that structural changes in organization, both within the Department and the Land Grant institutions, have not taken place as science has become more narrow, dug deeper, and required more highly trained integrators and interpreters. On the other side of the ledger, under the guise of accountability, the paper trial required by oversight creations of the bureaucracy have turned competent managers of the science system into lawyers and word processors. Flexibility and diversity which are the keys to the knowledge generation process have become secondary as the science community has been relegated to the seek-and-search way of funding characterized by short hops and knee-jerk authority to provide the quick fix.

It has become obvious that major changes from traditional organization patterns cause disruption in the normal informational flow patterns within an agency or institution and time is required for making modifications to develop a smooth working system. The regular reorganizational modes which have routinely taken place within the Department of Agriculture, with changes in the political power structure or motivated by peer pressure brought to bear by such as the National Academy of Science, are evidence of the case in point.

Fortunately, the basic working relationships between the traditional partners, and more recently, as much of the larger community of scholars, agencies and agribusinesses that are willing to pool their talents for the good of the nation, have remained in place. From the impetus given by the 1977 legislation, it would appear that in the three-year period since the organization of the Joint Council and Users Advisory Board, progress towards providing a communications vehicle for a much broader cadre of partners having a capability of contributing to the progress of a strong agriculture has been made. The wisdom of the proposed communications structure about to be set in place (and subject to further modification) and its potential for providing a framework for streamlining the knowledge generation and distribution system should become clear in the next five-year segment.

Recommendations:

1. The Joint Council on Food and Agricultural Sciences should be continued for an additional five-year period.

2. The primary purpose of the Joint Council should be to foster more effective research, extension and teaching in the food and agricultural sciences in the United States.

3. In developing a system to facilitate planning and coordination in the food and agricultural sciences use should be made of existing regional planning modes in order to build on past cooperative efforts.

4. That reports identifying the Joint Council's recommendations and priorities for agricultural research, extension and teaching and suggested performing organizations; summarizing ongoing programs, accomplishments and projected payoffs; outlining an integrated five-year plan be submitted to Congress, the President, the Secretary of Agriculture and constituent organizations represented by the membership of the Joint Council.

5. Reports summarizing activities of both the Joint Council and Users Advisory Board, together with recommended changes to facilitate program conduct should be submitted to the Secretary of Agriculture, the President and Congress well in advance of the presentation of the new fiscal budget in order to maximize the inputs made by the Council and Board.

6. In order to facilitate broad-based planning and coordination in all facets of agriculture and related subjects, it is recommended that close liaison be maintained between the Joint Council and Users Advisory Board by appropriate committees operating under Subtitle E, Animal Health and Disease Research and the Advisory Board established under the legislation entitled "The National Aquaculture Act of 1980" (PL 96-362).

7. The Act should be considered the basic charter for the operation of the Joint Council, and the Council should not operate under the provisions of the Federal Advisory Committee Act.

The Joint Council, as established by the basic legislation in the Farm Bill, was intended to result in the development of a closer linkage between the performers in the food and agricultural science and education system, including those who have not been considered an integral part of the traditional partnership. As the Council was organized and became a viable entity in the coordination process, it has become identified primarily as an advisory committee to the U. S. Department of Agriculture. While there are a number of reasons why this opinion is held, the fact that the Executive Director for Joint Planning and Evaluation serves in a dual role in the Department as well as Operations Officer for both the Council and the Users Advisory Board contributes to this impression. In addition, the fact that a considerable amount of the staff work necessary for responding to the mandated studies identified in the enabling legislation, as well as those studies which were carried over from the previous ARPAC operations, involved the professional staff of the Department further intensified the feeling that this was an "in-house" operation.

As a result, considerable effort has been placed on attempting to delineate the functions of the Joint Council. The results of these probes resulted in the general consensus that relatively few of the Council's activities were advisory to the Department of Agriculture. However, the advisory image has persisted and as a result progress toward evolving a more clear-cut planning and coordination process has been impeded. With this in mind, and with the objective of defusing further criticism, the following recommendations are put forward:

Recommendations:

1. Section 1407.(b). In order to provide greater representation from those organizations with significant research, teaching and extension responsibilities the membership of the Joint Council should be increased by at least five members selected on a regional basis from the Department of Agriculture, the State Agricultural Experiment Stations and Cooperative Extension Services, as determined by the Secretary.

2. Section 1408.(b) (1). The diversity of agricultural food, feed and fiber produced over a wide geographic area of the United States suggests that consideration be given to increasing the number of members representing producers of agricultural commodities, forest products and aquacultural products by five.

3. Section 1412 of the Act should be modified to insure that the six professional staff members authorized by the original legislation should be specifically assigned to providing staff support for the Joint Council and the Users Advisory Board.

   a. The Executive Director for both the Council and Users Advisory Board should be supervised by the Co-Chairmen/Chairman of the respective organizations, and administered by a member of the Secretary's policy staff.

   b. The non-federal Co-Chairman of the Council and the Chairman of the Users Advisory Board should be included in the selection process for the respective executive director.

4. Section 1413 should be amended to provide authorization for appropriating such funds as may be needed to carry out the provisions of sections 1412 (a), (b) and (c) and

Section 1413 (b), namely, the operations of the Joint Council and Users Advisory Board.

Prognosis for the Future - Tomorrow

Regardless of the pressures on system at the moment, it is important to recognize that dramatic changes in the manner in which information basic to management decisions in the agricultural enterprise are eminent. The explosion of computer technologies and the availability of hardware and software to integrate data bases providing decision makers with a variety of new management tools are here. As the adoption-diffusion process has unfolded and the technology transfer system has come closer to the researchers' laboratories and field plots, so will computer programs bring the library of research knowledge to the farm enterprise. These new tools of science, headed by the dairy herd improvement system of sire selection, will bring new pressures on devising national programs that will take the best of science to the field. The challenge to the partnership is to organize for the era of instant recall.

Appendix I. Joint Council Planning and Coordination

This report provides information on the most important functions for which the Joint Council on Food and Agricultural Sciences was created: coordination and planning. The Council has responsibility for fostering coordination and planning within and among research, extension and teaching programs with all of the partners in the U.S. food and agriculture science and education system.

At its first meeting in April 1978, the Council established an Organization Study Group. The group developed and analyzed planning and coordination structures that were circulated widely in the food and agriculture science community for reaction. After in-depth study and analysis, the Council adopted the structure shown in the second section of this report.

A Steering Committee on Planning and Coordination, appointed to assist in putting the Council's structure in place, suggested how various elements in the structure might organize and operate.

Later, a Special Committee on Planning and Coordination was appointed to assist the Joint Council in thinking through many of the important issues relevant to implementing the structure and getting it to operate effectively. Members of the committee represented the functional components of the agricultural science and education system (research, extension and teaching).

This report is based on contributions from the Organization Study Group; the Steering Committee on Planning and Coordination; the Special Committee on Planning and Coordination; staff papers and analyses; and deliberations of the Joint Council and its Executive Committee.

It is anticipated that this report will be of interest and value to persons appointed to Joint Council planning and coordination councils and committees; to Council members and their alternates; and to others who are interested in the planning and coordination functions of the Council.

While the Council tries to be helpful in providing information such as that contained in this report, it recognizes that many of the people appointed to Council planning and coordination groups -- as well as others -- have substantial experience and expertise in planning and coordination. The Council encourages initiative in developing and improving in its planning structure and processes.

This report is not the Council's final word on its planning and coordination functions; rather it is a recording of the present status in its evolving process.

Joint Council Planning and Coordination: Role and Objectives

Statutory Requirements of Title XIV

The Food and Agriculture Act of 1977 (Public Law 95-113) mandates the performers in the food and agricultural science system to improve planning and coordination activities and affords them an opportunity to develop and make available to policymakers, planners and others, summaries of what has been done and consensus statements on what needs to be done in research, extension and teaching in the food and agricultural sciences.

The Joint Council on Food and Agricultural Sciences was charged by the Congress to provide leadership in fostering coordination of the agricultural research, extension and teaching activities of the federal government, states, colleges and universities, and other public and private institutions involved in the food and agricultural sciences. The allied planning function was also highlighted in the Congressional charge.

The Joint Council's principal objective is to foster coordination and planning among all of the major performers of agricultural research, extension and teaching. The Congressional mandate requires that nonland-grant universities and public and private institutions involved in food and agricultural sciences be a part of the activities of the Joint Council. The membership of the Joint Council is reflective of this broadening of the food and agricultural science community, as well as coordination within and among the functions of research, extension and teaching.

Verbatim excerpts from Title XIV having special relevance to the planning and coordination responsibilities of the Joint Council are given in Appendix A. More briefly stated, the Title XIV requirements related to planning and coordination are:

1. Utilize an effective system of regional and national coordination and planning of agricultural research, extension and teaching programs.

2. Develop recommendations on long-range needs, priorities and goals in the food and agricultural sciences (five-year plans to be updated and submitted each year).

3. Develop recommendations on current needs, priorities and goals in research, extension and teaching (annual plans to be submitted each year).

4. Outline plans for coordination and delineate suggested areas of responsibility among partners in the agricultural science and education system (required in the annual report).

5. Summarize information on ongoing activities and achievements in research, extension and teaching programs conducted by organizations represented on the Joint Council (required in the annual report).

6. Analyze and evaluate the economic, environmental and social impacts of agricultural research, extension and teaching programs conducted in the U.S.

7. Provide a forum for the interchange of information among the organizations represented by members of the Joint Council.

Expectations of Congress in Establishing the Joint Council

Those who followed the development of the legislation report that in establishing Title XIV, Congress appeared to have the following convictions and expectations:

1. That there was some unnecessary duplication among partners in the food and agricultural science and education system.

2. That planning processes in the USDA, state experiment stations and state extension services should be developed and stated more clearly.

3. That unified plans with delineation of responsibilities developed by the Joint Council would help Congress in dealing with what appeared to be overlapping and competing requests from various components in the agricultural science and education system.

Council Philosophy and Policy in Regard to Its Role

Early in its life, the Joint Council articulated philosophies and policies regarding its role in planning and coordination which guided it in deciding upon its planning and coordination structure and in putting the structure in place. These policies which will continue to guide the planning and coordination functions of the Council, are:

1. The Council sees its role as one of fostering coordination and providing information,

encouragement and assistance to the organizations and agencies that conduct agricultural science and education programs. The Council provides a forum in which representatives of all components of the U.S. food and agricultural science and education system interact.

2. The Council believes that effective planning and coordination come about by consensus agreement through reasonably democratic procedures followed by performers who are well informed of ongoing programs, future needs, alternatives and constraints.

3. The Council supports maintenance of the integrity of existing organizations and agencies which conduct and/or help plan science and education programs. The Council does not intend to focus on planning and coordination within institutions and agencies, but hopes that its planning and coordination outputs will be helpful to them.

4. The Council visualizes planning as an interactive process and that in order to be effective, planning and coordination require continuous flows of information among all regional and national units in the science and education system. Beyond that, it emphasizes the importance of regional and state involvement in the process and feels strongly that the process should not be directed from the national level. This philosophy led the Council to decide to establish its regional councils and committees before establishing its national committees.

Objectives of the Council's Planning and Coordination Efforts

The objectives of the Joint Council's planning and coordination efforts are to enable the performers of research, teaching and extension in the food and agricultural science and education system to:

1. Continue and strengthen the responsiveness of the system to the needs of the users of food and agricultural science and education.

2. Continue and strengthen benefits to society from agricultural science and education.

3. Make more effective use of public and private resources devoted to food and agricultural science and education.

4. Develop and use reliable knowledge of the social, economic and environmental impacts of science and education in setting priorities.

5. Develop stronger public understanding and support of food and agricultural science and education.

Structure for Joint Council Planning and Coordination

Title XIV states that the Joint Council has responsibilities for "planning and coordination efforts in the food and agricultural sciences that utilize an effective system of regional and national planning."

Recognizing the importance of continuing the work that was underway as well as broadening the scope of planning and coordination functions, the Council took two actions at its first meeting in April 1978.

First, it elected to continue the research planning that had started under the National Research Planning Committee and its Regional Research Planning Committees. This work has continued under the Interim National Research Planning Committee of the Joint Council.

Second, it established an Organization Study Group to develop recommendations on organization of the Council, including structure for the Council's planning and coordination efforts. The Study Group developed three optional plans that were circulated for review and comment to Council members and to various organizations and agencies in the food and agricultural sciences. The wide circulation of the optional structures resulted in a large number of reactions, comments and recommendations.

The organizational structure for planning and coordination finally adopted by the Council is shown in the chart. The Council deliberated at considerable length before adopting this structure. There was complete consensus on the need for regional committees for each of the three functions -- research, extension and teaching. There was a good deal less unanimity on the need for both national committees for the three functions and for regional councils. The structure adopted called for both -- the national committees to accomplish national planning and coordination within functions and regional councils for integration and coordination across functions within each of the four regions. (Chart appears on following page.)

To emphasize the importance of planning and coordination in the regions, the decision was made to establish the regional councils and committees before appointing the national committees.

A Steering Committee on Planning and Coordination established ad hoc regional councils, then assisted these ad hoc councils in establishing the permanent regional councils. The regional councils are in the process of appointing the regional functional committees.

All regional and national elements in the Joint Council's planning and coordinating structure will be in place and functioning by late summer or early fall of 1980.

Organization and operation of the regional councils, regional committees, and national committees -- as outlined by the Steering Committee on Planning and Coordination in 1979 -- are shown in Appendices B, C, and D, respectively.

While the Council was going through the rather lengthy process of deciding on its structure and putting it in place, it carried out a number of planning and coordination activities on an ad hoc basis. The Interim National Research Planning Committee and the regional planning committees continued to operate effectively. Development of a five-year plan was led by an ad hoc committee of the Council. During 1979, the Council gave special coordination attention to human nutrition, integrated pest management and small farms. In 1980, work is continuing on integrated pest management and human nutrition, and energy in agriculture was added as an area for special coordination efforts.

It is likely that the Council will find continuing need for ad hoc committees for special purposes. However, when all elements in its structure are functioning, the amount of ad hoc planning and coordination activities likely will decrease.

Internal Linkages and Operations within the Joint Council Planning and Coordination Structure

The planning and coordination structure of the Joint Council provides the capacity to foster planning and coordination in two dimensions and at two levels: (1) within and across the functions of research, extension and teaching; (2) at the regional and national levels.

Improved planning and coordination within functions will help assure that both redirected and new resources will be channeled into emerging high priority areas. Improved planning and coordination across functions will not only stress the interdependence of research, extension and teaching, but will encourage a reasonable balance of funding among each of these functions. In addition, the communications and information linkages of the Joint Council must support its Congressional mandate to foster regional and national planning and coordination in the food and aggrculture sciences (these mandates are outlined in the first section of this report).

Information Needs

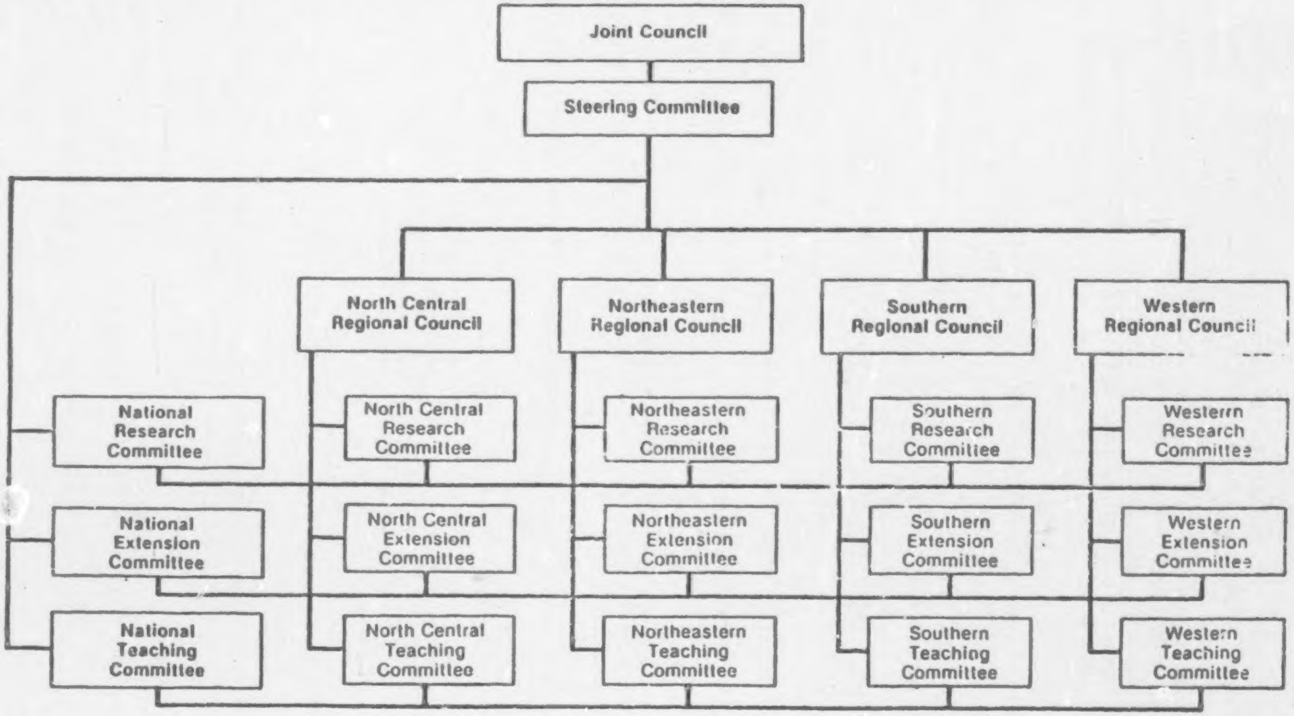
The Council requires information from all elements of its planning and coordination structure--regional councils, national committees, and regional functional committees--in order to achieve these objectives.

Regional planning and coordination require at least two other types of linkages. First, all elements of the structure must be free to relate to other elements within or across functions and within or across regions. The second type of linkage is related to the information which the regional councils, national committees and regional committees need from the Council to help them do their work. These information needs include:

1. Policies, guidelines, and suggestion of opportunities
2. Requests for information

Joint Council on Food and Agricultural Sciences

Organizational Structure for Planning and Coordination


Joint Council
Steering Committee
North Central Regional Council
Northeastern Regional Council
Southern Regional Council
Western Regional Council
National Research Committee
North Central Research Committee
Northeastern Research Committee
Southern Research Committee
Western Research Committee
National Extension Committee
North Central Extension Committee
Northeastern Extension Committee
Southern Extension Committee
Western Extension Committee
National Teaching Committee
North Central Teaching Committee
Northeastern Teaching Committee
Southern Teaching Committee
Western Teaching Committee

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3. Council reactions to inputs

4. Decisions of the Council

The regional functional committees (research, extension and teaching) will serve as the focal point for regional planning and coordination within a function. These committees are likely to be the initial place for developing information about annual priorities and five-year plans. A model for these activities might be the Regional Research Planning Committees -- established under the Agricultural Research Policy Advisory Committee (ARAC) and continued under the Interim National Research Planning Committee of the Joint Council. Although these committees have no counterparts in extension and teaching, the differences among them reflect the desirability of operational variations and adaptations to regional needs and to the unique needs of extension and teaching.

The diversity of needs in the food and agricultural sciences throughout the Nation makes flexibility essential. However, activities of the regional functional committees are expected to:

1. Identify regional needs for research, extension and teaching, and establish priorities for the implementation of plans.
2. Communicate regional needs to the regional councils and the national committees.
3. Develop and implement an evaluation system for regional programs.
4. Consider the pros and cons of establishing centers of emphasis.
5. Establish means of implementing plans and linking them with decisions about budget, manpower and facilities.

While all regional committees might be expected to perform these activities, some might have needs which are function-specific. For example, the regional teaching committees might consider the following thrusts:

1. Developing an inventory of higher education programs and an inventory of baseline data regarding them.
2. Identifying transfer agreements that exist among land-grant institutions, nonland-grant institutions, and those between the land-grant and nonland-grant institutions of higher education in food and agriculture.
3. Developing an inventory of instructional advances associated with agriculture, food and natural resources.
4. Identifying and summarizing trends in professional preparation in the food and agricultural sciences.
5. Sharing information about trends in placement and demands for holders of degrees from institutions of higher education in food and agriculture.

The initial focus for priority setting and multiyear planning would be within performing institutions and the regional committees. Regional information about priorities and plans within a function would be communicated along two channels to:

1. The national committees for research, extension and teaching
2. The regional councils

Communication Flows

The plans from the regional committees would be sent to the regional councils where across-function needs and plans would be developed. These regional plans would also be sent to the national committees. The national committees would use regional priorities and plans to develop a set of national priorities, plans and recommendations. The regional councils would use regional priorities and plans for research, extension and teaching to develop a set of regional priorities, plans, and recommendations.

The within-function and across-function information flows provide the Joint Council with two sets of recommended priorities and plans. Since the national committees will develop their plans with a knowledge of the regional needs and plans, this will simplify the Council's task of reconciling the two sets of reports before developing its recommended plans.

Planning and coordination are possible when enlightened self-interest of the parties is maintained by information. The planning and coordination structure of the Joint Council can generate information both within and across the functions of research, extension and teaching. In addition, the structure is capable of generating this information at national, regional, and institutional levels. This information is also available to users; scientists and educators; national, state, and local political decision makers; and administrators at all levels.

Communications to the Council from the regional councils and the national committees are likely to produce two different types of consensus. The regional committees and the national committees are likely to develop a consensus for within-function needs. A second consensus is likely to be developed by regional councils for across-function needs like integrated pest management, rural development and energy. The Joint Council will have received national priorities and plans for research, extension and teaching, and it will also have received regional priorities and plans across functions.

Facilitating Communication

Planning and coordination can be fostered by the processes used. Interaction among performers generates information while it increases the basis for understanding, coordination and commitment. An overlapping membership among the regional councils and both the national committees and the regional committees is a structural device which increases the opportunity for understanding, coordination and commitment. Since functional priorities and plans proceed to the Joint Council through functional channels, the functional perspective is preserved. Likewise, regional priorities across functions are channeled to the Joint Council through regional councils. The flows in both channels can be facilitated by an overlapping of membership and the commonality of interest in terms of function or location.

Communication would be facilitated if the Council standardized the information format used by all committees and councils in its planning and coordination structure. As a common program structure and data base develops, this problem may be simplified. One important step in this direction has already been taken. In October 1979, the Council appointed a Program Structure Study Group to: (1) look at the information needs of Council members, (2) inventory and assess structures presently being used, (3) suggest ways of bringing about more uniformity or compatibility in program structures, and (4) consider the program structure needs in the Council's planning and coordination structure.

This Study Group presented its findings and recommendations at the April 1980 meeting of the Joint Council. At that meeting, the Joint Council made the decision to proceed with the development of a common program structure that is compatible with the program structures being used by component members of the Council.

External Linkages between the Joint Council and Others in the Food and Agricultural Science and Education System

Nature of External Linkages

External linkages are contacts and relationships with outside institutions or individuals that are formulated by the elements of the Joint Council, i.e., the regional councils and the national and regional research, extension and teaching committees. Linkages are and must be at least two-way. The elements of the Joint Council will receive signals through its linkages with performers in the food and agricultural science and education system. Elements of the Joint Council will also send signals to the performers.

The elements of the Joint Council cannot influence without being influenced. Feedback information must be received through linkages for them to convey the message of the Joint Council to performers. Performers must be aware of and receptive to the information before they can favorably consider it and use it. The intermediate products of the linkages produce the contacts, the relationships, and the channels of two-way information flow.

The means for forming external linkages are:

1. Providing for representation of the external groups on the elements of the Joint Council--regional councils and national and regional committees.
2. Setting up a responsive and effective communication system so that external groups:
    a. Receive timely and accurate information from elements of the Joint Council.
    b. Send timely and accurate information to elements of the Joint Council.

Linkages with Performers

Performers are represented by a number of federal and non-federal organizations and institutions. Those most directly involved with the conduct of agricultural research, extension and teaching programs include:

1. Elements of the National Association of State Universities and Land-Grant Colleges (NASULGC), including:
    a. Division of Agriculture
        (1) Council Administrative Heads of Agriculture (CAHA)
        (2) Experiment Station Section and its Committee on Organization and Policy (ESCOP)
        (3) Extension Section and its Committee on Organization and Policy (ECOP)
        (4) Resident Instruction Section and its Committee on Organization and Policy (RICOP)
        (5) 1980 Research Directors and 1980 Extension Coordinators
        (6) Commission on International Agricultural Programs
    b. Council of 1980 Presidents
    c. Commission on Home Economics
    d. Commission on Veterinary Medicine
2. Regional associations of experiment station directors, extension directors and directors of resident instruction in colleges of agriculture
3. Public and private colleges and universities through representation by the American Association of State Colleges and Universities (AASCU), the American Association of University Agricultural Administrators (AAUAA) and the American Association of Universities (AAU)
4. Agencies of the U.S. Department of Agriculture, including:
    a. Economics, Statistics and Cooperatives Service (ESCS)
    b. Forest Service (FS)
    c. Science and Education Administration (SEA)
5. Private industry
6. Foundations that conduct or facilitate research, extension, teaching or international programs in food and agriculture

Linkages with performers will be most effective and efficient when their representatives (recommended from each of the groups) are active members of the appropriate element within the Joint Council. This is the principal means through which the influence of the Joint Council on performers and the influences of the performing groups on the Joint Council can be realized.

Those components of the performing groups that have national scope would have primary interaction with the national elements of the Joint Council; those that are regional in scope would interact primarily with the regional elements of the Joint Council.

Linkages with federal agencies and coordinating bodies involved in research or education programs related to agriculture are desired and there is need to have interaction with them. These include, among others:

1. Office of Science and Technology Policy (OSTP)
2. Office of Technology Assessment (OTA)
3. Committee on Food and Renewable Resources of the Federal Coordinating Council on Science, Engineering and Technology (CFRR/FCCSET), a committee specified in Title XIV which has representation from 12 agencies of the federal government
4. National Science Foundation (NSF)
5. National Academy of Science/National Research Council/Board on Agricultural and Renewable Resources (NAS/NRC/BARR)
6. Environmental Protection Agency (EPA)
7. Department of Energy (DOE)
8. Department of Interior (DOI)
9. National Institutes of Health (NIH)
10. Soil Conservation Service (SCS)

Liaison representatives from these groups to the national committees and the Joint Council is an alternative. OSTP is represented by membership on the Joint Council.

Linkages with Users and Other Groups

The National Agricultural Research and Extension Users Advisory Board (UAB), established in conformance with Title XIV, is a national advisory group. The UAB is an important linkage with a diversity of user interests through exchange of reports between it and the Joint Council, annual joint meeting of the two groups, and the fact that two members of the UAB also serve as members of the Joint Council.

Linkages with users for the regional elements of the Joint Council can occur principally through the information flows established by the regional councils with representatives of users.

National advisory groups; local, regional and national organizations; and public and private foundations and institutes are also important external entities for which information flows to and from the Joint Council need to be established or improved.

Major responsibility for communications with state and local government officials lie within the state entities performing agricultural research, extension and teaching. Regional councils will need to explore the types of communication links and the kinds of information that the state performing entities can effectively use with their state legislatures. Communications from the regional councils to the legislative officials can most appropriately flow through the administrative heads of the relevant performing institutions within the states.

Information Components

The major components of external linkages are information development and information sharing. Information must be targeted to common core program structures within functional areas (research, extension and teaching) and also among those functional areas where they interface. The important information that should be sent to external groups and received from them include:

1. From external groups to the Joint Council:

    a. Important societal problems requiring research, extension and teaching consideration.

    b. Programs that external performing agencies currently have underway addressing these problems and the resources committed to these programs.

    c. Indications of what other programs are needed to fill the knowledge gaps and the resources needed to carry out these programs.

    d. The results that are forthcoming from science and education programs (both actual and expected results) and how these results may be used by elements in the Joint Council planning and coordination structure.

    These information inputs to the Joint Council from external groups would be used in its activities to assess the following: (1) priorities for agricultural research, extension and teaching programs; (2) development of five-year plans for the food and agricultural sciences; (3) achievements by the performing groups in conducting research, extension and teaching programs; (4) progress in coordination of the research, extension and teaching activities both within and among the performing agencies; (5) evaluations of ways to improve the performance, conduct and effectiveness of these programs.

2. From the Joint Council to external groups:

    a. Policies, opportunities and constraints on planning and coordinating food and agricultural sciences programs.

    b. Requests for information for improving program conduct and effectiveness.

    c. Decisions of the Joint Council regarding priorities, recommendations for program conduct, division of responsibilities, funding levels, etc.

    d. Special studies; task force reports; research, teaching, and extension program results and publications; etc.

Communicating and Using Joint Council Outputs

No information is useful until it is communicated and put to use. The payoff from Joint Council activities will be reflected in how well the five planning and coordination objectives of the Joint Council (outlined in the first section of this report) are achieved. These payoffs will be particularly affected by how well the Joint Council carries out the following activities:

1. Communications for use with the performing groups that have the reponsibility for building budgets and to those performing groups responsible for using funds to carry out research, extension and teaching programs.

2. Communications for use with users at the national level (EPA, DOE, etc.); regional level (farm organizations, commodity groups, professional associations, regional commissions, etc.); and state and local level (consumers, producers, business firms, and state and local governments, etc.).

3. Communications that elicit commitment on the part of the performing groups to actively participate with the Joint Council in carrying out joint planning and coordination.

4. Communications that explain the possible uses of outputs of the Joint Council as they become available, and encouragement of the use of them by both performers and users.

5. Communications that explain and document the benefits of joint planning and coordina-

tion activities relative to the investment required to carry out the planning and coordination activities.

6. Communications that explain task force reports and special study committee reports and recommendations for use of them as they are forthcoming from the Joint Council elements.

Resources for Joint Council Planning and Coordination Activities

Scientists, Educators and Administrators

The time of scientists, educators and administrators who participate in Council planning and coordination councils, committees and task forces is the most important input that will be involved in planning and coordination.

It is anticipated that all organizations represented on the Council will contribute the time of their scientists, educators and administrators who participate.

Staff Help

Staff help will be needed at both the regional and national levels to achieve the objectives of the Council's planning and coordination efforts. More specifically, it will be needed to help the 12 regional functional committees, the four regional councils, the three national functional committees, the Steering Committee for Planning and Coordination (or its successor) and to some extent, the Council itself in its deliberations on recommendations from the regional councils and national committees.

In an ideal world, the Council would have its own staff paid from funds obtained from voluntary assessments of organizations represented by members of the Joint Council.

In a slightly less ideal world, council members might collectively support one or a few core staff. Council members might in addition agree to encourage qualified members of their staffs to assist with staff work as needed on assignments that match their specialties and skills.

As it is, some members may not have the resources to contribute to the staff effort. In other cases, mechanisms for tapping the resources available may need to be developed. This may apply especially to teaching and extension partners, to nonland-grant universities, and private industry.

Following are comments on two general sources of staff help for Joint Council planning and coordination activities.

1. Staff supplied by the USDA

   In Title XIV, the USDA was given legislative authority to provide staff support to the Joint Council. While the USDA is not in position to provide all of the staff help needed to support the Council's regional and national planning and coordination efforts, it is willing to make a significant commitment.

   Most of the staff assistance to the Council would be provided through the Joint Planning and Evaluation Staff (JPE) in SEA. This professional staff is made up of a combination of core staff in JPE; staff detailed to JPE by other units of SEA, ESCS, and FS; and Intergovernmental Personnel Act (IPA).

   The professional staff available to the Council through JPE consists of: (1) part-time Executive Director; (2) full-time Executive Secretary; (3) a special staff of four three-fourths time professionals serving the Joint Council and the Users Advisory Board; and (4) time as needed and available from a staff of specialists in subject matter and resource analysis (budget, manpower, facilities).

   It is anticipated that the USDA staff would concentrate on assisting with planning and Coordination activities of the Council itself, the Steering Committee for Planning and Coordination, and the three national functional committees.

In addition, the USDA staff should be able to assist the four regional councils and the 12 regional functional committees (if they desire such help from this staff) by: (1) providing national summaries, analyses and projections, with regional breakdowns; (2) making suggestions on effective processes of planning and coordination; and (3) assisting with the communication flows among the elements in the Council's planning and coordination structure, and perhaps also linkages with organizations outside the Council's struture.

2. Staff assistance from other sources

Additional staff support will be needed to assist in the regional and national planning and coordination efforts of the Council. Other sources of staff help may include:

a. State agricultural experiment stations. SAES are already providing considerable staff support to the regional and national research planning effort through their Regional Directors-at-Large; through personnel of IR-6, Interregional Project on Planning, Evaluation, Analysis and Coordination of Research; and regional rural development centers.

b. State cooperative extension services. CES are now providing some staff support through regional rural development centers, regional media coordinators and in other ways.

c. Resident instruction personnel in land-grant universities.

d. Personnel from nonland-grant universities.

e. Foundations.

f. Private industry.

Appendix II

A. Statutory Requirements Related to Planning and Coordination

Following are verbatim excerpts from Title XIV of the Food and Agriculture Act of 1977 (Public Law 95-113) having special relevance to planning and coordination responsibilities of the Joint Council:

Section 1407

(d)(1) The primary responsibility of the Joint Council shall be to foster coordination of the agricultural research, extension, and teaching activities of the Federal Government, the States, colleges and Universities, and other public and private institutions and persons involved in the food and agricultural sciences.

(2) The Joint Council's responsibilities shall also be to --

(A) provide a forum for the interchange of information among the organizations represented by the members of the Joint Council that will assure improved awareness among these organizations concerning the agricultural research, extension, and teaching programs, results and directions of each organization;
(B) analyze and evaluate the economic, environmental, and social impacts of agricultural research, extension, and teaching programs conducted in the United States and determine high priority agricultural research areas, and submit annual reports identifying such high priority research areas to the Secretary;
(C) develop and review the effectiveness of a system, for use by the Secretary, of compiling, maintaining, and disseminating information about each federally supported agricultural research or extension project and, to the maximum extent possible, information about private agricultural research and extension projects conducted by colleges and universities, foundations, contract research groups, businesses, and others...
(E) assist the Secretary in carrying out the responsibilities assigned to the Secretary under this title through planning and coordination efforts in the food and

agricultural sciences that utilize an effective system of regional and national planning, and by the development of recommendations and reports describing current and long-range needs, priorities, and goals in the food and agricultural sciences and means to achieve these goals;

(G) prepare and submit to the Secretary, not later than December 31 of each year, a statement of recommendations which shall include --

(i) the Joint Council's recommendations as to unified national, regional, or interstate agricultural research, extension, or teaching programs to be implemented during the following fiscal year, delineating suggested areas of responsibility for Federal and State agencies in carrying out such programs, and the overall planning, evaluation, coordination, and support necessary for such programs, and

(ii) a summary of agricultural research, extension, and teaching achievements made during, and the status of ongoing projects as of the end of, the prior fiscal year, with respect to the programs conducted by the organizations represented by the members of the Joint Council.

Sec. 1410. The Secretary shall submit to the President and Congress by February 1 of each year a report on the Nation's agricultural research, extension, and teaching activities, and such report shall include --

(2) The statements of recommendations of the Joint Council developed pursuant to the provisions of section 1407(d)(2)(G) of this title and the statement of recommendations of the Advisory Board developed pursuant to the provisions of section 1408(f)(2)(E) of this title; and

(3) in the second and succeeding years, a five-year projection of national priorities with respect to agricultural research, extension, and teaching, taking into account both domestic and international needs.

B. Regional Councils

Appointed by:

The Joint Council following recommendations by the ad hoc regional councils and subsequently by the regional councils.

Membership:

Include representation from groups and organizations identified by the Joint Council as potential nominees for membership, as well as others deemed appropriate by ad hoc regional councils. Will vary according to the region; e.g., the Western Regional Council would not include a representative from the 1890 group. Might include at least one member from each of the three functional regional committees -- research, extension, and teaching.

Structure:

Regional council, executive committee, subcommittees, or other structure to address a particular issue or study area, particularly when called upon by the Joint Council to assist the regional council in carrying out responsibilities which are assigned to the Joint Council, e.g., evaluating impacts of food and agricultural sciences, review the effectiveness of different entities associated with agricultural research, extension, resident instruction, and others.

Functions and Operations:

1. Establish and coordinate regional committees on research, extension, and teaching, giving particular attention to problems and issues which cut across the three functions.

2. Develop and adopt rules of operation of the regional council, including such matters as standard operating procedures for conducting meetings (location, time, support logistics, and others), means of communicating with other groups and organizations, both within the Joint Council organizational structure and outside.

3. Review recommendations from regional committees and make this a prompt process. The regional councils may request the regional committee submitting the report to undertake further work and development, as appropriate.

4. Place national problems before the Joint Council and national functional committees.

5. Serve as a communications channel between research, extension, and teaching in the food and agricultural sciences and the public sector.

6. Identify program areas encompassing agricultural research, extension, and teaching.

7. Promote cooperation in the development of program components in research, extension, and teaching within the region.

8. Develop a coordinated plan for the implementation of regional programs in research, extension, and teaching.

9. Establish a plan for periodic reviews of research, extension, and teaching programs conducted within a region.

10. Schedule periodic meetings at least annually, involving representation from research, extension, and teaching subcommittees to facilitate the implementation of programs across the functional areas.

Communications:

1. Serve as a communication channel with the Joint Council regarding regionally integrated efforts of the three functional regional committees.

2. Bring to the attention of the appropriate national functional committee problems and opportunities, as well as to the Joint Council.

C. Regional Committees

Appointed by:

Regional councils

Membership:

To be determined by the regional councils. May include but not restricted to specialists, professionals, and others involved in research, extension, or teaching, a person with membership on the specific national functional committee, a person with membership on the regional council.

Structure:

May develop subcommittees to be composed of a broad range of other professionals (health, environmental protection, energy, and others) from the grassroots level in the major program areas that research, extension, and teaching are emphasizing. Each subcommittee may have a professional liaison from each regional committee.

Functions and Operations:

1. Elect officers and establish structure, develop operating guidelines, establish a timetable for meetings and production schedule.

2. Develop lines of communication for dialogue with peer groups, national functional committees, and regional councils.

3. Focus on research, extension or teaching problems within the region in order to assist the Joint Council in achieving its legislated functions:

The following are suggested as specifics for each of the three functions:

Research:

1. Identify regional research needs and establish priorities for the implementation of projects.
2. Consider the need for establishing centers of excellence and regional contributors.
3. Establish on a regional basis a system for communicating with clientele groups.
4. Establish a channel of communication with the National Research Committee and the Joint Council.
5. Develop and implement an evaluation system for regional research programs.

Extension:

1. Identify regional extension needs and establish priorities for the implementation of programs.
2. Interface with clientele and/or users groups to identify areas of concern and to communicate information about in-place programs.
3. Communicate regional extension needs to the Joint Council through the appropriate regional council and the National Extension Committee.
4. Establish a periodic review system for ongoing programs within the region.

Teaching:

1. Establish a channel of communication with clientele groups to provide an effective interchange relative to educational programs and clentele needs.
2. Continue and refine the manpower assessment at the regional level.
3. Communicate potential needs and related information (including areas with surplus manpower) concerning graduates to educational institutions within the region.
4. Identify educational needs specific to the region.
5. Communicate regional educational needs to the regional council and the National Teaching Committee.
6. Develop a regional system of communication among educational institutions.
7. Organize regional conferences and symposia to effect educational development in new and emerging areas as appropriate.
8. Develop and implement a regional evaluation of educational programs.
9. Establish regional priorities for utilization of federal support.

Communications:

1. Problems and issues may be referred to regional committees by individuals and by both the regional councils and national committees.
2. Regional committees are responsive to both regional councils and national committes.
3. Regional committee reports may be submitted directly to the respective national functional committees without regional council approval.

D. National Committees

Appointed by:

Joint Council, with advice of regional councils.

Membership:

To be determined by the appointing body and may include at least one member of each of the specific regional functional committees (research, extension and teaching).

Structure:

To be determined by the respective national committees.

Functions and Operations:

1. Elect officers, develop procedures of operation and establish lines of communication with the Joint Council, regional councils and regional functional committees.
2. Develop national plans for program areas and subareas within the functions and establish priorities, identify problems and opportunities.
3. Develop plans and mechanisms to achieve national coordination within their functions and subareas thereof.
4. Foster the adoption of national plans and coordination mechanisms among all public and private partners in the food and agricultural science and education system.
5. Integrate the work of and foster interactions among two or more regional committees within their function where relevant.
6. Assist the Joint Council and its constituents in the consideration of specific national problems and opportunities within its function.
7. Consolidate programs identified and priorities established by regional councils and regional committees.
8. Identify national programs and establish priorities.
9. Serve as a communications channel between regional functional committees and the Joint Council, as well as provide liaison between the Council and the regional committees.

Communications:

1. Receive from and send information to regional functional committees, and the Joint Council.
2. Exhange information with working groups and study units of the Joint Council.

Appendix 2. Joint Council Planning and Coordination Structure.

Subject: Joint Council Planning and Coordination Structure

To: Partners in the Food and Agricultural Sciences

Over the past several months, the Executive Committee of the Joint Council has been reexamining the planning and coordination structure that the Council has been putting into place over the past two years.

We have attempted, in our discussions, to be responsive to the concerns expressed by partners in the food and agricultural sciences, as well as continuing to comply with Title XIV to improve planning and coordination between Federal agencies and State institutions, and across teaching, research and extension. We know that this system will only be successful if it has broad support and acceptance by the science and education community.

During its February meeting, the Joint Council, after hearing recommendations from the Executive Committee, adopted a modified planning and coordination structure which has the following major features:

1. Regional Councils will remain in place to address regional concerns that "cross-cut" higher education, research and extension.
2. National committees for higher education, research and extension will have a strong leadership role in planning and coordination activities at the national level.
3. Regional functional committees for research, extension and teaching are optional. National committees are expected to obtain input from local, State and regional interests in whatever way they deem appropriate. Regional Councils may carry out their functions with or without regional functional committees.

Suggested responsibilities of the Regional Councils and National Committees are as follows:

1. Regional Councils

   - conduct selected planning and coordinating activities which cut across research, extension and teaching.
   - insure that the Joint Council has the benefit of regional perspectives in its various activities especially in developing five-year projection of priorities.
   - identify and analyze science and education policy issues important to the region and recommend policy directions for relevant decisionmakers.

   Partners in the Food and Agricultural Sciences

   - serve as a forum for information exchange among the leadership of the region and serve as an opportunity to resolve problems of mutual interest.
   - suggest issues for the attention of the functional committees.

2. National Functional Committees (research, extension and higher education)

   - develop an indicative plan (target) for a national program for the functional area.
   - monitor progress of national programs and recommend changes to the appropriate administrators.
   - assist the Joint Council in its various planning and coordination functions, especially in the development of five-year projection of priorities.
   - identify and analyze national science and education policy issues for the functional area and recommend policy directions to the appropriate decisionmakers.
   - serve as a forum for information exchange among the leadership of the functional area and provide the opportunity for resolution of problems of mutual interst.

The Joint Council represents a diverse and decentralized food and agriculture science and education system where planning and coordination must take place largely in a voluntary manner and in a way that does not violate the autonomy of the various institutions and organizations that conduct the programs. At the same time, we strongly believe that it is in the best interest of the system and the Nation that a sound system for coordination and planning exists and that the one adopted by the Joint Council will work -- but only if it has your support.

Anson R. Bertrand Cochairman	John S. Robins Cochairman

Commissioned Paper IV

THE PROCESS OF SETTING PRIORITIES FOR FOOD AND AGRICULTURAL RESEARCH

Charles E. French

Office of Technology Assessment
December, 1980

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THE NATURE OF THIS PAPER

Since this paper lays quite a bit of ground work before it gets to the point, let us outline here its line of argument:

First, we do have a problem of priorities in food and agriculture -- the people arguing this point of view have a real concern.

Second, this "problem" is exploding into a complex policy issue -- and, the good intentions of trying to define it in its last detail would better be turned to simplifying it.

Third, our "old processes" for deciding research priorities are breaking down -- probably they can no longer establish defensible priorities among research activities, let alone set the policy agenda for the big issues in food and agriculture.

Fourth, fortunately, some "new processes"[1] have been evolving -- and, they have had enough testing to show promise.

Fifth, the "new processes" were not designed explicitly for use by food and agriculture people -- but possibly they can be adapted.

Sixth, these "new processes" show more promise as guidelines than they do as a formula -- yet, some people are trying to make them into a formula.

Seventh, fortunately, we need guidelines more than we need a formula -- so, this paper on process has a place in this broad evaluation exercise by the Office of Technology Assessment on food and agricultural research priorities.

THE EXPLICIT PURPOSES OF THIS PAPER

This paper by its nature is not so much a stand-alone paper as it is a supplement to others in this exercise, especially the two by Fishel[2] and Knutson, Paarlberg and McCalla.[3] Also it draws heavily on the Kellogg Foundation Lecuture by Castle.[4] The two central purposes of this paper are modest by comparison with the purposes of those three papers.

First, this paper attempts to offset two potentially damaging impressions that may be drawn from several other recent papers, especially in the OTA group -- a) pessimism about the performance of the research system and b) frustration that it is impossible to improve anything so inextricably complex as the research system. Thus, this paper hopes to infuse some optimism and some simplification.

Second, this paper attempts to use some evolving process ideas in two helpful ways -- a) by providing a conceptual framework in which people in good faith can reach a consensus on several important policy issues about agricultural research and b) by illustrating process concepts that will sharpen the decisions being made on research priorities themselves. Thus, this paper ho[illegible] to infuse some direction and some discipline.

"THE PROBLEM"

The problem of setting research priorities is characterized by:

1. An unprecedented pressure for even greater performance from the U.S. agricultural and food research system. This pressure is heightened by the spectre of world hunger and the promise which the North American research systems bring to solving that problem.

2. An aura of expected change. This is typified primarily by some of the complicated planning recommendations of the Food and Agriculture Act of 1977. Also the wide array of studies documented by the Fishel paper illustrate expected change. Certainly, this evaluation exercise by the Office of Technology Assessment came about mainly because of the fact that Congress

expects change.

3. Lack of a strategy for improving the system. Controversy on this issueabounds and basically this is what the OTA study is all about. A positive strategy is needed, but unfortunately it must have some defensive posture as well because the system does have enemies. Also, new participants have strong egos about their expertise and some have positive, but misdirected intentions. The need for a strategy is buttressed further by strong self interests, many social needs competing for scarce resources, budgeting processes often grasping for straws, and general social recoil from public approaches to such problems.

4. A confused, ill-defined process. The traditional processes for approaching this problem have evolved with little logic, comparability or additivity. One hope of this paper is that it will crystallize some thought on being more systematic in how the problem is approached. Also, process will become even more critical as a better defined strategy evolves.

5. An increasingly dynamic setting for research. Research results increasingly have a shorter and shorter half-life. Modern dynamics put the system under great pressure to be flexible and adaptable, and add to the problem.

6. Inadequate information base and poor communication. Several, including Fishel, have pointed out that much of the priority problem lies in poor communications and an inadequate information system. This places impediments in the way of implementing research priorities.

7. An impending danger of pessimism and futility about the system. The attention given the system has documented its complexity and led to futility about it. Hopefully, better processes can turn this attention into a positive, rather than a negative force.

The problem is not necessarily the performance of the system. Arndt, Ruttan and others[5] have made quite positive evaluations of the performance of the system itself. This paper concurs and makes a plea that users, research administrators, budget allocators, politicians, and others treat the record for what it is. The record stands on its own. Unfortunately, glibness, ridicule and pseudoattempts at anti-sophistication are often used to interpret the record in such a way as to catch the headlines. The system is basically sound and can be a force in world peace and human advancement. However, its performance will suffer unless some changes are made. The fact that some argue that its performance is already in question is unnecesary to justify the need for change.

The problem in not necessarily the complexity of the system. But the system is complex and becoming more so. Like most things in life, it takes more doing on the part of those who hope to manage this complexity than it did previously. This paper will emphasize simplifying our approach to this highly complicated problem.

The problem is defined in many ways and the other papers dramatize that. Actually, the above definition of the problem may be more illustrative than substantive, but hopefully it places the need for the better processes in perspective.

GETTING HOLD OF THE "PROBLEM" BY BREAKING OUT ITS COMPONENTS

As indicated above, one has only to read part of the papers in the OTA exercise to conclude that the total problem of agricultural and food research is complex. In fact, one easily gets the notion that it is beyond hope of solution. Fortunately, we have known since Decartes that such despair is human. Also we have known since Decartes that process can simplify life and make some things manageable. Hopely due process will do that for us with this "problem." If we can identify its components, we can concentrate our shots. The "problem" has at least these five substantive components.

Food and Agricultural Policy Agenda. Thanks to Paarlberg for his notion of a policy agenda.[6] He knows well that such a policy agenda is not synonomous with the research agenda,[6] but many others do not seem to know that and, admittedly, some policy and research issues can be intertwined. But separating the two is a helpful conceptual idea. Policy notions have exploded in complexity. We have expanded the traditional dimensions of domestic price and income policy from innocent-looking subjects such as social security for farmers or rural school reorganization to rural and economic development and rural poverty. Such dimensions exploded again when we added interactive areas such as social sciences, energy and environment. Later they exploded again with international aid, development and trade. Research needs have expanded in somewhat analogous ways, but the research agenda is not the same as the policy agenda. Also, we must hope that it is not as far-reaching as the policy agenda. More on the research agenda later.

Political Coalitions. Thanks to John Kramer[7] for advising us on the need in agricultural and food policy for more sophisticated agricultural coalition-building and the political strategies back of that. He did not have research specifically in mind, but even researchers must consider politics and strategies in order to survive. His notions have embedded these ideas into the current definition of the "research problem." Again, political science and strategy are important, but they are not identical with research. Also, we must hope that they are more encompassing than agricultural and food research.

Institutional Innovation and Integration. Thanks to Castle[8] for crystallizing the institutional issues affecting food and agriculture. He knows that they are not identical with research, but his emphasis on and insights into the institutional problems have caused some to attempt to put them within the research problem definition. Jurisdictional issues emerge within both the Federal and State domains. Also, complicated relationships exist between these two domains. Then these domestic problems explode with those of the evolving international research and policy-making institutional network. Add to this the education and service dimensions of the land grant complex and you explode the problem again. Institutions are important, and have important implications for research priorities, but their overemphasis can cloud the research-priority problem.

Special Strategies and Tactics. Thanks to the public administration types for teaching agriculturalists new managerial ways of doing business. To impress the budget agencies you need more modern approaches to program priorities and evaluations. To define your positions with individual congressmen, congressional staffs, and user groups, you operate your research programs in certain ways. For example, if you fail to keep your eye on the continuation and size of your research budget, setting priorities may become unnecessary! Also, the scope of the budget surely affects the priorities chosen. But, much of the strategy for getting more money should be kept out of the decisions about what should be done with the money you do get. This total budget issue is important, but care should avoid its dwarfing the research-priorities part of the problem.

Research Activities. Thanks to the many forces which are causing us to think about chosing research activities of highest priority. And those who understand priority setting know that the range of research activities can transcend from projects to broad multidisciplinary approaches of national policy goals, if not to ideologies. Thus, the priority-setting exercise must be tuned specifically to the purpose and level of activities in mind. Thanks to Fishel for arguing that priority sets if defined too universally become meaningless. This paper takes him seriously on that point, but it is much more optimistic than he about it. This paper argues that we can define rather specific priority sets within this "research problem." Moreover, we can get meaningful consensus on them.

THE PROBLEM FOCUS OF THIS PAPER

Above we sorted out the components of the problem. We did that so that we can deal with important activities on an appropriate level of abstraction. This paper argues that we will make more headway if we concentrate on that component of the problem which we defined last -- research activities. Research activities can be tackled at a manageble level of abstraction, but we must be specific within the broad area. To use "new processes" to improve our research priorities, we must be careful about what assumptions we make with regard to the other components of "the problem." We need more disciplined processes than we have been using if we are to do that well. We need to recognize the partial nature of our analysis; face squarely some of our strategic and political assumptions; accept our self interests; face the realities of our resource limitations; and use the tools we have for deciding research priorities. We need better to define some of the problem components other than research activities and go to the proper fora in which to resolve conflicts about those components. The rest of this paper will focus on restricted orientation for establishing research activities.

THE INADEQUACY OF THE OLD PROCESSES

Despite problems, the food and agricultural system has performed well and has momentum. Its strength lies in the stability of its organizational arrangements, the experience and expertise of its management, the know-how of its scientists, the history of its service to both the public and private agricultural establishment, and its contributions to other people worldwide.

For some, the popular theme is "if it is not broken, don't fix it." That cliché is not very helpful -- we must recognize that parts of "the system" are broken. The papers in the OTA exercise and others provide an imposing inventory of alleged difficulties. And to many, the prognosis for solving these problems is gloomy.

Let us again recognize, however, that much of what is broken is not necessarily within the research system itself. Rather, many of the broken parts are imputed as being part of "the problem" when really they are not; they are actually policy, politics and other things that surround the research system. This paper concentrates on recommendations for improving the broken parts of the research system itself, but especially upon repairing our broken system of priorities among research activities.

The old processes have served us rather well, but new processes for improving the system are necessary for at least three reasons.

First, decisions will be made. We cannot afford to make them by default. These decisions are important and deserve to be tackled positively by a responsible process.

Second, most of the expertise for making appropriate decisions is within the system itself. While greater pluralism may be justifiable, the burden of proof of that rests primarily with its proponents -- and most of them are outside the system. The record of the system is too commanding to allow the leadership of the system to abandon without deep thought its role for internal decision-making. These decisions vitally affect the destiny of the system.

Third, and most important, an evolving new planning process seems somewhat legitimatized by the Food and Agriculture Act of 1977. Many believe that such a process could threaten the system. This paper is not commissioned to evaluate that process itself. But the author of this paper has real concerns that the process is not in the best interest of appropriate research priorities. Castle says that the research system itself is a "troubled and uncertain system" and the proposed system of national planning and coordination "is a vast exercise in hyprocrisy." That disturbing evaluation is endorsed by others including Knutson *et al*. Also, this OTA exercise generally reflects doubts. Experience with the proposed system to date fails to generate hope on the part of many inside and outside the system.

The position of Knutson *et al.* on the appropriate setting for the priority process is close to the bias of this paper. They argue that the success of the system comes from its "operating in a relatively free-market, agricultural and...decentralized research setting where scientists in proximity to their agricultural clientele make the critical decisions on what research is to be done." Further, they add that "aside from clientele contact, administrators' discretionary incremental research funds, competitive grants and normal attritions have been the primary means of modifying the mix of research that has been undertaken." This paper attempts to build on these notions.

A near paradox exists in that this paper recommends tightening the system precisely to preserve those free aspects Knutson *et al.* espouse. Times are gone when the public will allow the autonomy enjoyed in the past. Unless those managing the system and the scientists themselves accept this tightening, both will lose control to interests outside the system. If they go to a highly pluralistic system, such as is evolving from the Food and Agriculture Act of 1977, they will strangle themselves in bureaucracy, self-interests, and inaction so that indirection will move the decisions outside the system. If they resist public attempts to build in accountability and pluralism, they will have the decisions taken away directly. They must work within the system to adapt it to the changes that are occurring in its setting. Otherwise, the inevitable result is to lose the freedom now in the system.

What is needed is a strategy which can discipline the system, protect the integrity of the system, retain reasonable control of the system, provide a framework to accept society's demand for more pluralism and accountability in the system, and give more positive direction to the system.

The "new processes" for approaching this problem are promising, have taught us some things, and deserve our study, experimentation, and use. Essentially, they recognize that the decision process is heavily laden with judgment. Interestingly, that is the same judgment that the managers, scientists and Knutson et al. are fighting to preserve. The recognition and the acceptance of the need for this judgment are the most prominent and important notions in the new conceptual step forward as discussed in this paper for improving the priority of our research activities.

But, the "new processes" do more; they afford us ways safely to expand the role of judgment so it can include more of the judgment of the new actors as well. This gives the public its pluralism -- not an incidental contribution. These processes also allow us more exacting and efficient information sources and basis for communication. Moreover, they force a much more rigorous consensus among the various judgments where conflicts are now so rampant and counterproductive.

We often use judgments; but as a concept, we are loose about it. Despite the admonishment in Matthew 7:1 not to do so, people make judgments about people. For example, making judgments about scientists, students, and others has been an accepted practice for a long while. Psychologists and behaviorists have improved our processes until consensus judgments about people are often rather tight and comfortable. Modern personnel managers and bankers, among many others, propogate their profession on these notions.

Subject-matter concensus judgments are another matter. Consensus there comes hard, and our processes have blinked at the lack of consensus, shrouded it, or come up with very loose consensus, indeed. Anyone who has served as a judge to evaluate publications, alternative teaching packages, or research proposals in such as professional awards competition must acknowledge this fact. Moreover, debate judges decided long ago to judge presentation, not content. This argument can be debated, but it has much validity.

Lack of consensus in our judgments about research and other subject matter areas is a problem. We should face that fact. The people evolving the "new processes " have been tackling this problem. We must take advantage of their efforts.

THE "NEW PROCESSES"

Let us return to the rather loose term "new processes" which we said was to be used purposefully. Initiatives included in the term are rather new and process-oriented. Also, these initiatives are diverse, changing and difficult to describe. The processes have been evolving from several disciplines or professional fields -- agricultural sciences, especially agricultural economics; behavioral sciences; operations research both from the multidisciplinary and quantitative orientations; quantitative economics; management sciences; utility theory; statistics; and others. Many of the new processes date mainly from World War II. They are part of the age of cybernetics -- the new mathematics, probability theory, computer models, information theory, behaviorism, artificial intelligence, and whatever else you include in that vital scientific impact of the Post-War period.

Many of the developments have come from multidisciplinary efforts. The purposes for which they were developed have been varied -- theory development for its own sake; specific maximization issues, especially of economic use of scarce research and development funds; policy guidance for a range of institutions including professional societies, trade associations and public research agencies; management techniques over a range of problems in evaluation, planning and assessment of research programs both public and private; and others.

Both concepts and procedures have been of interest, so this has caused different groups to be interested for different purposes and has kept the permutations and combinations of ideas growing and in a state of flux.

It is the combination of concepts, process rigor, and commonality of ideas that stimulated this paper. Excuse the term "new process" but it seems about as descriptive a term for our purposes as is available.

Prior to 1965 most of the "new-processes" work was conceptual and experimental with no one person or group doing extensive work, and applications were quite thin.[9] Agriculturalists became interested in this work and did some evaluation of the work done up to the late 1960's and early 1970's. The work by Shumway was rather thorough and is recommended for anyone tracing this early history.[10] Shumway, with help from Dale Hoover, has given us a clear picture of why that agricultural interest developed at that time.[11]

"While the decision process for allocating resources among research efforts varies considerably between organizations, the following approach has been reasonably typical. The management system consists of the administrative officer, department heads, and professional scientists. In the project funding process the administrative officer judges project outlines submitted to him by department heads who previously analyzed proposals prepared by a large number of scientists, most of whom have tenure. Decisions about individual projects are largely made on a year-to-year basis by each scientist acting as an entrepreneur on behalf of his own professional life; if he chooses projects which are not rewarding to the funders, other scientists, and the administration, then he suffers. A great weight is placed on him for selection of the appropriate projects. The decision function involves not the selection and funding of specific projects so much as it is the employment of specific scientists who will be attached to the research organization for a considerable period. Emphasis is on maximum freedom for the scientist to select projects and undertake desired research with minimum control or direction from administrators. Furthermore, if experiment station administrators are not willing to support specific research, the scientist there is normally free to seek grant funds from outside sources.

....

"Soon after World War II, as public investment in research began a two-decade period of rapid growth, investigations of alternative approaches to manage research were reported for the first time. Stimulus for such work came primarily from corporate managers concerned with the rate of return from investments in research as opposed to other activities and from government funders anxious to prevent waste from the rapidly growing budget. Since the availability of scientists was lagging behind, it was a seller's market. Research had little difficulty securing funds for interesting problems.

"In recent years, however, the cycle has peaked and the supply-demand relationship changed. Federal research and development expenditures have leveled off and substantial decreases have occurred in several areas, including atomic energy and space. Nonfederal expenditures have continued to rise, but not enough to offset even the effects of inflation. With greater competition among scientists for available funds, internal pressures have recently surfaced for more intensive investigation of management processes.

"Attention is focusing more directly on the research administrator, an important link between funding sources and scientists. It is he who must account for current expenditures of funds while assuring significant achievements over time from a highly uncertain production process; he must allocate support funds even though he cannot program breakthroughs; he must keep scientists' morale high and give them sufficient latitude to perform at their best at the same time they are competing more strenuously for limited resources. Or, he can solve the increased competition problem simply by allocating support funds evenly among all researchers or in proportion to salary. He can also reduce the size of his research staff through attrition and/or termination of untenured or noncareer scientists. He or his designates can evaluate the merits of the research proposals and specify which will be funded and how much. Here he will find an impressive array of management techniques generated in recent years, the objective of which is to help him be internally consistent and/or increase his likelihood of receiving essential information to formulate a valid judgment."

At that time, Shumway classified the relevant processes of interest to agriculturalists into two large classifications: a) Project Ranking Processes (One-dimensional ranking methods, including individual participant "comparative" method and group-determined measures of benefit processes and multidimensional ranking methods including information systems, scoring models, and benefit contribution models) and, b) Approaches for Optimizing Resource Allocation (Benefit-cost analysis, optimization models specially for research, simulation, and network models.)[12]

The first group attempts to place judgment on research priorities into some rigorous process and increasingly has used judgments of several people; so consensus-making is important. The optimizing techniques are more sophisticated and depend upon levels of information that were not available at that time and probably are still not often available. The last group, optimizing techniques, must be part of the "new process" that the research system strives to use, and some use of these notions has been made; however, the conceptual ideas of the first group, project ranking processes, are more interesting to this author and thus, are much more the focus of this paper.

Fishel in unpublished work has surveyed the work with agricultural implications done since 1965.[13] He concluded that it has been so profuse and diverse as to be fadish and non-additive. Both of these criticisms are probably true, but usually both characteristics are necessary in order to get new ideas developed to the point of high-payoff application. Thus, we should take a good look at what can be done to refine these efforts so future uses will be more selective and additive. The needs of this paper do not require, and resources do not allow, in-depth work on that in this paper, but a methodological assessment of the papers inventoried by Fishel along with other relevant ones would be a profitable exercise to be undertaken by some one interested in the problems identified by this OTA exercise.

Some of the characteristics of the methods introduced above will be detailed more later, but let us summarize their characteristics most relevant to this paper:

1. Their conceptual notions are probably more useful than are their procedural notions. This is ironical since their developers were often procedural experts.

2. Their group aspects are not political, but more diplomatic; thus, the consensus idea. Actors are assigned distinct roles, and democracy is not intended or practiced. This is in contrast to most of the planning concepts being proposed, such as in the Food and Agriculture Act of 1977.

3. Their diversity has been to their detriment. The lack of concentration has restricted their application and has added to their faddishness. This need not be a liability. Since their diversity makes for a rich field of investigation for applied and integrative managers such as those responsible for the research system. And, even their faddish nature can make them attractive in political forums such as in Washington.

4. They are highly formal in organization about mathematical, statistical, and behavioral aspects. This makes the more independent-minded person (such as researchers and

politicians) resist. Also, it tends to make extensive information demands. The research system probably should be able to meet such demands, but has not. The irony of that lies in the fact that probably no one respects good data more than do researchers.

5. They are multidisciplinary and that calls for cooperation and compromise. These characteristics are not demonstrated as being natural parts of the research system and will call for adaptation by research managers.

6. They are modern in their topological and iterative characteristics. This makes them conceptually attractive in the dynamitic setting sketched above for the research system.

7. They demand rigor in differentiating between what is known (in a scientific sense) and what must be handled with probability notions. Scientists live on their ability to push from the known into the unknown. The astute manager will see this opportunity to relate to the scientist on his own ground.

8. They are of a family of processes in which agriculturalists, especially agricultural economists, have found a comparative advantage. For example, many operations research processes (such as mathematical programming) have been developed by the specialized quantitative and behaviorial scientists, but many of the exciting applications have been made by the integrative researchers and practitioners such as agriculturalists. These processes present a continuing opportunity for both agricultural researchers and research managers. Fishel developed a classification of what he called priority sets. In many ways these illustrate uses that have been made of the "new processes"; so his classification is useful for our purposes:

"This categorization resulted in the following five categories of priority sets:

1. Priorities established externally to the Food and Agricultural Research (F&AR) system. These include studies that were established outside the F&AR system organizations with participants at least predominantly (seldom exclusively) composed of persons not part of the traditional F&AR system. Also included are the monographs and articles of individuals...referred to as 'monitors' of the F&AR system.

2. Priorities developed in F&AR system-wide national studies. These include reports of studies that consider the system in its entirety, encompassing all the traditional F&AR system organizations and most if not all disciplines and commodities. Participants are mostly from the traditional F&AR system organizations. The National Inventory Study and the NRC World Food Study are examples of such studies.

3. Discipline-oriented priority sets related to a single discipline or an area of related disciplines. These too may be national studies but of more directed interest and discipline-oriented participation. Studies have included animal health, weather modification, plant stress, energy, and many others. These were also prepared mostly by participants from within the F&AR system.

"4. Formally structured priorities developed by and within the F&AR system. These are priority sets that are at least intended to have direct influence on research conducted and/or the budgets that support the research. The USDA-SEA/AR National Programs and the USDA-SAES Five-Year Projects as well as budget development materials are examples of such priority sets.

"5. Implicit priorities that evolve out of the normal research activities of the F&AR system. It is characteristic of research that research projects selected are highly influenced by the discoveries of scientists in preceding research projects. Discoveries lead to discoveries and technologies lead to new technologies. This is the most common pattern of research progress, one research project evolving out of the findings of the preceding project. Unfortunately, this is not an easy type of priority to document or to find in the literature. There have been a few studies that at least indirectly trace this effect (Purchase on poultry vaccine; Smith on soybean harvester), usually related to technology assessment."[14]

The most a paper of this type can do is set a conceptual tone, make a plea for direction, cite stimulating literature, and hope that others will find help as they tackle problems which the author and they have in common. This most cursory and out-of-date review of the "new processes" is no more ambitious than that. Obviously, it does not do the "new processes" justice in their own right, but possibly it will suffice for our current needs.

AN ILLUSTRATED PRIORITY-SETTING STUDY OUTLINE

The processes available are many and the uses of those processes are even more. The following is an outline of one approach which can serve as a starting point for any one of the uses in the five priority-setting classifications of Fishel above. It will be illustrated by some of the decisions made in the National Academy of Sciences *Food and Nutrition Study* (F&NS) of 1977.[15] Bear in mind that this outline is illustrative and the decisions made in the F&NS are not necessarily identical to the type needed for another use. However, the steps of this outline cover the key areas in which one must make decisions and the approximate sequence in which one must make them for most priority-setting studies.

What is the study setting? The origin and background of the study must be kept in mind. The communication problem in these studies is difficult. Participants can be many and involved at different times. An understanding of the study background by all is useful if not mandatory. Also, people outside want information. A formal statement well conceived and articulated can save much time, especially of study staff. Probably more important, this conceptual orientation of the purposes of the study is so important that it should be written down for the discipline of the study team if not for other reasons. The F&NS needed both written material and many face-to-face meetings with interested groups and individuals.

One must be explicit as to whom the priorities are intended. Just as any author must decide upon his audience, so must a priority setter decide upon his. This needs to be nailed down specifically and early. The F&NS priorities were for the President. Everyone in every decision kept that in mind. Also, it is prudent to look past that one key audience to others affected, and they should be enumerated as specifically as possible. For example, in the F&NS there were two Presidents concerned; all major Executive Branch research administrators were aware of and/or involved in the study; Congressional members and staffs were interested; many scientists were heavily involved and the science community at large was interested; international interests were involved and interested; nearly every vested interest group in food and agriculture was interested; and on and on. The basic policy was to advise the Presidents in the way most useful to that office, and to visualize how others would interpret and use what we gave the Presidents. In addition, five volumes of supporting papers, which were not essential for the Presidents' use, were compiled and have had extensive use in this country and abroad, especially by policy makers, science managers, scientists and teachers.

A key question is, "how much are the priorities to stand alone?" This may appear to be part of the issue of the priority audience just above, but it is so important conceptually it is singled out. In some uses, the budget may be allocated explicitly along the lines of priorities established as would probably be the case in a commercial research laboratory for any one year. More often, the priorities are at best recommendations, if not simply a pruned-down list of alternatives designed only as one input for a big policy decision. Care must be taken early to be sure just where the priorities fit into the final decision of ultimate concern. In F&NS the impact obviously covered many levels with many subtleties and combinations of other decision input material. Yet, in the F&NS it was known that a rare opportunity existed to affect explicit Presidential decisions on research budget size, budget allocations, research institutional arrangements, international policy, and other matters. These uses needed thought, some cataloging, and some prioritizing themselves. But emphasis was on what the President should know in order to make decisions on research priorities per se.

Part of the study setting has to do with the relevant time dimensions. The time allocations both overall and for component parts of the study itself a[illegible]portant. But the ones in mind here are with regard to when the research will have impact. This issue is complicated and probably varies within the priority set. But it is vitally important in establishing choice criteria, relevant range of the priority set, and much of the process design. The time elements can and must be established. The F&NS concentrated on research impacts for two periods of time -- within the next 15 years and after 15 years (with an implied assumption that research on hunger issues past 2000 probably would at this time have low priority). Also, key sequence problems were outlined and study teams were given explicit assumptions about considering time issues.

The study setting is greatly affected by the appropriate resource constraint assumptions. Most priority-setting exercises assume a constrained optimization problem.

The budget constraint can have important disciplining and orientation effects upon the actors. In research the constraint usually is not just the dollar budget; constraints can be institutional capability, personnel availability, cross effects on alternative program priorities, political climate and a host of others. The F&NS had a strategic problem in that it had to give guidance on the size of the budget as well as on the allocation of the budget. It had to consider essentially all of these constraints, as well as special constraints such as time limits needed for urgent breakthroughs. Constraints come in for much discussion and decision making in F&NS, and adequate coverage of that would need more discussion than appropriate here. Actually the main constraint was on the researchers to nominate for the priority set only their "best shots" for important impacts upon world hunger. They knew that the final priorities would include only a few high-priority selections from any one area or group of scientists. This was a serious constraint and put them in a discriminating posture. The F&NS staff assumed that it would get enough priority set nominations to give a range of priorities. Moreover, the staff memebers had judgements about policy and budget constraints which led them to believe that the priority set would not be fully subscribed. So this type of constraint was assumed in order to get the important concerns of the scientists while getting enough nominations for a range of priorities adequate to exhaust the resources likely to be forthcoming. This, then, was not an unconstrained problem, but it was more loosely constrained than would be true of many applications of the processes.

Different problems will have different assumptions and different considerations which must be made for the particular problem setting. F&NS had many more than the above, but these illustrate the type of problems with which one must deal.

What Are the Constraints on the Study Itself? These processes offer a range of applications within any one study. They can fit a grand design or something much less. Hardly any limits exist on how far one can go in procedural technique. For example, procedures can be designed to handle issues on descriptive detail of each unit in the priority set, the number of actors involved, the tightness of the consensus, and on and on. Thus, we must get a practical feel for what kind of resources are available for the study itself. The above examples show a feel for the type of considerations needed. Also, a special problem exists in that a critical mass probably exists and that is necessary before we can use the approach, but let us bypass that for now.

The approach to restraints in these processes is quite similar to the approach to restraints one would use when making similar decisions in other study approaches. However, one can easily explore new-process approaches past the feasible resource constraints--one of which is the tolerance of people who are to participate in the exercise.

The F&NS had a large budget with the opportunity to use many of the great resources of the Federal government and those of the private and public scientific community to say nothing of the prestige value of the White House and the National Academy of Sciences. Yet, F&NS omitted many things which it would have liked to have done and it would be inappropriate to list them! Suffice it to say that the following were some of the study constraints: a) time for completion of the study as imposed by negotiation with the White House, b) the amount of time and the type of participation to be tolerated by the various actors (which was by any standards generous on their part), c) dollars available, d) time allocated to public relations for the study, e) balance between depth of any one type of decision input vs. the number of different types of input to include in the study (such as public hearings vs. iterations of the decision makers for the purpose of tightening the consensus, f) publishing plans turning on such as staff time, actor preference and Presidential needs, and g) many other procedural decisions such as number of probability calculations, processing techniques which would assure necessary study momentum , and how many staff people should attend what meetings.

Who Are to Be the Actors? This section will illustrate this item, but the importance and range of issues with regard to actors are so important as to be highlighted among items discussed separately below. Suffice it to say that the F&NS study had both decision makers and informers as discussed below.

The key decision makers were several. First, the Steering Committee of the Study was composed of a distinguished public body, especially well accomplished in science. Second, F&NS staff which interacted with and obviously influenced the Steering Committee. Third, the most important was a study team of experienced and respected scientists with recognized science careers, administrative and managerial experience, knowledge about public policy making, a cosmopolitan style about world and domestic food and nutrition issues, and a general reputation for being broad and progressive thinkers. This list of their attributes is abbreviated, but it is at least illustrative. They read the entire priority set; were briefed on process by the Staff, Steering Committee, and other team chairpersons; went through a Delphi type consensus process; and made the key priority ranking which they submitted to the Steering Committee and Staff. This discussion certainly does not do justice to their efforts, but space precludes that. Fourth, other groups critiqued the priority rating and gave reaction to the Steering Committee before it made the final priority ratings. These groups included: within the NAS, the Board on Agriculture and Renewable Resources, Food and Nutrition Council, Publications Review Board, and many individual staff members particularly in the Commission on International Relations and the Divison of Biological Sciences; an inter-agency advisory committee which cut across many Federal government agencies; and several others. The Steering Committee was obviously much more influenced by the decision-making study team of generalists described above than by anyone else, and rightly so.

The informers were primarily thirteen other study teams of scientists (about 10-20 members each) selected for outstanding science careers, specialized in a given subject matter area such as research on crops, but interdisciplinary to some extent in expertise such as in agronomy, plant genetics, agricultural economics, and others. They were given detailed instructions on what should go into the preparation of the nominations of the priority set from their study team. They held extensive hearings with other scientists in their field; asked other scientists to make some specialized contributions; discussed their nominations with F&NS staff; to some extent prioritized their own study team nominations;

and detailed the written statements on each nomination. These nominations were used for the decision-making study team of panelists and as the basis for the supporting-paper volumes referred to above. These study team members did much more, but that was the essence of their job. This input was supplemented by wide input from many other scientists (about 1000-1500) including that from four workshops from about 200 other foreign scientists. Other committees were used by F&NS staff as informers where appropriate, and there were several of them.

What are the Criteria for Choice? This topic will be illustrated briefly here but is important enough for separate discussion below. Also, the criteria are interwoven with the next topic, "What is Included in the Priority Set," but arbitrarily the criteria question will be discussed first. F&NS had two overriding criteria: the probability that the research would be successful and the expected impact of it. These were applied for each of the two time periods (less than 15 years and more than 15 years). Other important criteria were the cost of doing the research and the cost of implementing the research so as to help alleviate world hunger. Other specific criteria covered special needs such as ability of the research to break a key bottleneck, to solve a critical geographically oriented problem, to complement other priority research, or to open up an extremely high potential area. Another criterionof importance was joint utility of the research for both the United States and other countries.

What is Included in the Priority Set? This topic is illustrated here but also detailed below. As already indicated, F&NS placed a strategic design constraint on the study teams and relied heavily on the scientists to come up with the priority-set units for their area. Essentially all nominations by the teams were included although some similar ones, especially when nominated by more than one study team, were combined by F&NS staff. Also some combining was done to even out comparability of priority set units in such characteristics as scope of the units. The choice of what to include was hardly that simple and, of course, was really decided in large part by the subject-matter orientation of the study teams set up. Also, to some extent the members chosen for the teams influenced the type of units to be expected. The nature of the study team subject matter areas took much staff time and Steering Committee analyses and deliberation. This was a key effort. F&NS probably was greatly simplified in the procedure compared to other possible studies since it was commissioned to study the whole field of food and nutrition worldwide but with emphasis on what U.S. scientific leadership could influence. Thus, it did not have many of the controversial boundaries in other more specialized studies. However, this also made for general complexity of units proposed and for more unusual nominations for the priority set. The division of study emphasis between nutrition and food was hotly argued. Also, the natural science emphasis vs. the social science input was argued. Generally the more traditional food and nutrition areas emerged and the number was manageable. The first set of study teams designed impressed the Staff and Steering Committee as having the potential of being too conservative in their nominations. Thus the two teams were set up with the expressed purpose of nominating more unusal and higher risk types of ventures.

What are Plans for Implementation? Some would not necessarily include this as part of the outline, but Fishel, Brady, [16] and others have argued that the best of priority-setting studies are of little avail unless implemented. Fishel has argued that proper procedures for priority setting can improve implementation. Studies at the national level with an eye to affecting policy have a long history of gathering dust. So implementation plans and possibilities for obtaining continuity in studies should always be in mind. Regularly scheduled follow-up replications of many studies make sense. The F&NS here had reasonably good implementation but lack of specific plans for implementation is generally recognized as a serious flaw in the study. Some thought has been made to repeating at regular intervals a revised version of that study. This author thinks that such a study possibly should be conducted about every five years. Such an effort certainly would be compatible in principle with the recommendations of Knutson et al. for overall evaluations of the research system.

REACHING A CONSENSUS

The most important guidance we have received from the "new processes" deals with developing a consensus. This point is made recognizing the risk of overemphasizing the importance of consensus *per se*. But the truth is that we have no consensus on the problems of the agricultural research establishment and we need it. The costs within the food and agricultural research system which are intolerable lie in a range of real or perceived problems of: a) lethargic indecision, b) internal bickering and resultant weak bargaining power, c) bureaucratic constipation of national planning systems, d) unnecessary meddling by "outsiders," e) failure to communicate in a clearly distinguishable way, and f) underrating society's expectations about putting some parts of the research house in order. Consensus by those within the system upon how to define and attack these problems would be useful. Also, negotiations and mutual decision-making on any of these problems must be undertaken by insiders with some help from outsiders. Also, consensus-making techniques may have use in building the inside-to-outside bridge. In fact, the agricultural research leadership could attain a positive advantage by proving such an objective systematic forum in which to agree. They could move out front with this approach and meet the outsiders on more favorable terms.

Consensus is a concept that has different meanings to different people. This is to be expected; it is a concept with diplomatic overtones. It is to be used to minimize conflict, but to get on with sticky matters while protecting your right to change your mind later. Essentially it involves two components--agreement and judgment. Webster's dictionary defines it as: "group solidarity in sentiment and belief; general agreement; the judgment arrived at by most of those concerned". A definition derived by S. F. Lowe, a "new processes" methodologist with much field experience, is the one used in this paper: "A consensus is when most people agree to go along with the general idea and no one is strongly opposed to it.[17] This definition applies to the priority set in total; it need not apply to the priority established for each unit of the priority set.

The givens in consensus-making are rather straightforward. In order to develop a consensus one must decide: a) *who* is to consent, b) on *what*, and c) for *what purpose*. Each is discussed below.

Some General Notions about Consensus-making. Three general notions about this consensus process are important enough that we need to discuss them before we talk about the three more specific ideas of who, what and why.

The first general notion is that the process must protect the integrity of the individual. This is particularly important where the decisions affect several different individuals or groups, many of whom have conflicting self-interests. We already have found this to be the situation in the research system. Also, individuals perform differently in group dynamics, so the process by which they interact is important in terms of the type of input they make to the decision process. The "minority" interest in pluralistic environments is an indigenous and growing problem of the United States. As we have seen, the push for pluralism in the research system certainly brings this issue to the fore. The whole notion of the protection of the integrity of individuals' inputs can be germane whether we are considering basic scientists or specialized user advisory panels. We may want to weight the impact of different individuals differently in the processes, but the rigor of the system prevents our blinking at this issue as we have had a tendency to do.

The second general notion is that the process demands rigor -- more than most decision makers like, particularly if they are scientists or agricultural administrators. Rigor is the watchword of the priority-setting methodologist. It permeates his approach generally, but is most obvious in three areas -- in his definitions, in his quantitative measures or indicators, and in the forced choices among alternatives.

Definitions are explicit and useful. They are important. If the actors in a priority-setting process circumvent the rigor of definition, the process will fail. The three most important definitions are probably the three already mentioned -- who, what and why. But, many other definitions are taken seriously, such as time periods for probable payoff of research, the sequencing of research, costs of research such as both actual analytical funds and total implementation funds, nature of institutions involved, non-human resources available and needed, human resources with particular regard to training implications and timing of availability, absolute and expected levels of resource budgets, and many others. Researchers are more tolerant of the rigor of definitions than are users or decision-makers, but all three can benefit by this aspect of these processes.

Quantitative measures provide some of the best information furnished those trying to reach a consensus. Such measures are of two basic types. One type includes measures used to establish definition so the relevent comparisons can be made among different defined items. The definitions must contain a heavy quantitative element where possible. The second type of measure is to guide the consensus makers directly in their processes. These give the range in judgments of the consensus makers in enough detail so areas of consensus emerge quickly. The assistance of such measures in saving time can be enormous. They show the areas of wide variation in judgment as well as the shewnance of it. This immediately pinpoints the areas and the specific actors among which variations in judgment must be compromised if consensus is to be gained. More important, such measures pinpoint the reasons for the judgments and establish the persuasiveness of the arguments behind the judgments. The anonymity of the actors to this point in the consensus process has assured that the integrity of each individual has been captured in the measurements per se. This is vital. Quantitative notions of probability can also delineate known parts of the general problem under consideration from the unknown. This narrows the area of decision-making based upon judgment and gives guidance on the level of the risk being taken. Research project and program writeups are sharpened by this type of sorting the known from the unknown.

Finally, the third element of rigor is in the forced choices. Forced choices are the driving thrust for disciplining the actors. Alternatives exist; people must choose; and if their choices take them outside the consensus, they must defend their choices or change them. Most of us resist choices, especially the tough ones. These processes make us realistic about the situations in which people can be expected to make a reasonable judgment on a choice and those in which they cannot. If a reasonable choice is thought possible, it is expected to be made. Next the judgment is examined and finally tabulated to see if a consensus exists. If not, an environment has been created in which well-meaning people can change their judgment and make another choice. They are not preempted from changing their minds -- just the opposite, they are encouraged to do so.

The third general notion of the process design is that it must provide for iteration. Improvements in the consensus must result as the process moves along. Feedback is a powerful modern concept and it proves itself again in the priority-setting process. The process is sequenced. Much thought is given to what is done when. This sequence is designed to give protection to the individual, to avoid forming judgments before the facts are in, to provide the basis for iteration, and to provide general structure and rigor to the iterative process.

Deciding Upon Whom to Involve. We have established that the research system has many actors involved and possibly no brew can survive this many cooks. We will be modest and not consider in this paper that the possible solution to our problem is exclusion of some of the actors. However, we would be remiss if we did not say that we do think exclusion is a worthy topic for political decision. This section will discuss only how the actors might be classified so the priority-setting process has a chance to use each to his or her comparative advantage.

Identification of who's who, what each does, and what others think he/she does would go a long way in sorting out the problem in agricultural research regardless of the priority-setting process used. Fortunately, such identification is imperative in using most of the newer priority-setting processes. This step in the process is valuable in its own right but it also forces rigor into other parts of the process.

One classification of the actors identifiable in the priority process for food and agriculture research follows:

a) Users
b) Society representatives
c) Managers
d) Scientists
e) Others

Any classification is arbitrary and this one is no exception. The subject-matter issue discussed in the "what" section to follow have much to say about who is an actor and what kind he or she is. In agricultural research, the domestic and international priority criteria increasingly cloud the actor classification problem. The public and private identification also cuts across classifications. So the above classification is only a guide, but it is a start.

Priority-setting methodologists make what at first seems a curious division between the actors -- decision makers and informers. This distinction turns out to be quite helpful and will be used in the following discussion of the five types of actors classified above.

The decision makers are not well identified in the research system, and their responsibilities may be shifting. The priority-setting people would say that this should be tidied up. This paper concurs. The industrial psychologists have a heirarchy of involvement which may be quite helpful on this problem. They start with an assumption that people interested in the particular decision want to feel that they have been involved in that decision. They suggest four levels of involvement by an individual or group of individuals in a decision with a descending level of responsibility and involvement: a) Delegated responsibility for the decision, b) Delegated responsibility for a recommendation, c) Delegated responsibility for identification of the alternative but not for a recommended choice among them, and d) Simply information about the decision, preferably before it is made. This paper recommends that the research priority-setting process identify the responsibility of decision makers accordingly.

The informers are the ones who prepare the stage for the decision makers. The theory of the "new processes" suggests two broad types of informers -- those who set the limits and rules of the game for the decision makers and those who provide the facts about what is to be decided. This classifiction by types shifts back and forth among the various actors depending upon the particular priority-setting exercise. But, in any one exercise the roles are essentially mutually exclusive. Even if they merge, the actor should try to be conscious of which role "hat" he or she is wearing, when.

With this background, let us discuss the research actors.

Users have always had a role in influencing priorities about what agricultural research is to be done. This is by political process, by voluntary advisory roles, by feedback through extension-type linkages, by pressure through innovation of their own such as top farmers consistently have done, by funds cooperatively provided, and by a host of other ways. Users probably have an exaggerated view of their knowledge of what priorities should be. But they do have a valuable input and they will demand that the process accommodate that. And it should. The process must spell out how much responsibility users have for the decisions themselves. This paper recommends that their role be essentially that of informers. They should be involved in setting the limits and the rules and in providing the facts. In selected instances, their making decisions on a priority set can be helpful. This is true because this definition of users assumes that the user has some specialized knowledge about the priority set under consideraion.

Society representatives[18] are a varied lot and many are probably users as well. The main distinction on that point is the level of specialized knowledge held. The key society representatives in the research system are Congress, public supervisory groups such as boards of trustees of research establishments, specialized budget allocating groups, and others who set general policy about research. Their role should be essentially as informers to the research priority-setting process. And that informer role should be essentially one of influencing the rules of the game and the limits set on the decision makers.

Managers include most of the administrators, both public and private, who run the research system. This group is diverse and growing. The specialized budget allocating groups were classified as society representatives, not managers. This paper contends that managers should be limited in line with their limited knowledge about the research _per se_. The manager group often has varied special interests, wide responsibilities other than research, distinguished but outdated research careers, significant concerns about total availability of research resources, and a host of other characteristics affecting their actions. The priority-setting methodologists would question how well they could be expected to function as decisionmakers. Also, the methodologists would mistrust much of their judgment on specific facts about the priority sets. Regardless, the facts of life are that to this date the business of the research system has resided substantially in their hands and it probably will need to continue to do so. In all honesty, this is to some degree by default. No other group has both the capacity and motivation to do it. The managers must be included in the deicison-making role and they must provide many of the rules and limits which govern the decision process. They cannot be autonomous, and must share these responsibilities with other actors including the scientists, as argued below. They should be cautious and exercise more humility than now about their capacity to serve in the informer role. That is not their comparative advantage, but they have some contribution to make to it.

Scientists have had a key role in decisions about research priorities. The bias of this paper is to preserve a high degree of that. But several facts suggest that scientists will need to yield some of their influence. Often they do not care specifically about society's research interest. Also they are not always convincing that they care about society's research needs as well. They have surrendered some of their power because they will not put up with the trouble of preserving it. They have lost some respect by the general public and thus will be held more to accountability and less on faith. They lack the breath of understanding of society, just as everyone else does, to make decisions with such broad societal impact; pluralism is a growing characteristic and they will be a part of it. The complexity of the decisions in broad priority sets raises real questions about the opportunity cost to specialized scientists of figuring into broad priority-setting exercises. Despite all this, the scientist is still the best expert on research priorities. The system must fight to protect that. He must have great freedom to make key priority decisions in his specialized field, especially in basic sciences. He must take time to protect his input as an informer into the limits and rules of the game for setting priorities. He must share his knowledge about the facts of priority sets. Thus, the scientist is important to science! The riddle is how to divide his precious time. This is even more reason why the system must stay off his back where it can and let him ply his trade. The scientist must recognize his plight and realize that he cannot go on as before. He has some adapting to do. To have him deal himself out of the research priority-setting process by default would be catastrophic for him and society.

Others can have a role in this process. How to get pluralism and accountability is difficult. Many would say that this paper is so biased toward the scientists and their administrators that "the goat is assigned responsibility for the cabbage patch," and they may have a point. All of society has this problem to a degree. The processes conceived here have room for expertise to be used among peers without giving in to special interests. This means that research administrators and scientists must be accountable. This can cut across scientific specialists, across countries, and across institutions in prescribed and cross-checking ways. This paper cannot design this, but the author is convinced of the possibilities.

The idea of consultants obviously is raised. The potential for use of experts to provide facts about priority sets is high. But the expert arbitrator also should be considered for decisions where consensus is otherwise impossible. Other actors, such as the National Academy of Sciences or the professional societies, have special roles to play. The private research agencies have made much use of the priority-setting process. Some of the above professional institutions have the capacity to acquire assistance in the use of those processes and have a comparative advantage of objectivity not biased by special interests. Thus, they may have a special public obligation to do this type of priority setting. This certainly applies to Federal agencies such as OTA, GAO, and OMB.

Other actors must be brought into the process along the lines discussed above. The key to this component of the process lies in defining the roles of the actors and then choosing the best actors possible.

Deciding Upon the Bases for Consensus. The new processes have several rules of the game for gaining a consensus but conceptually the most important ones deal with the criteria for deciding the priority among the items being prioritized. Let us discuss why such criteria are necessary and how we can go about setting them up.

Why Have Criteria? First, the criteria are essentially to guide the judgment of the decision-makers, or judges. These processes respect the wisdom and power in judgment. The methodologist with a narrow point of view tries to avoid judgment and tries to design a procedure to replace it. He fails just as did the early accountants who thought accounting would replace judgment. The wise methodologist is more like the modern cost accountant; he uses his process to guide and facilitate judgment.

Second, we need criteria to guide communication. The first communication bridge crosses from the setting of the study as conceived by those who commissioned it to the judgment of the decision-makers or priority setters who must organize and design the study. The next bridge crosses from the design of the priority setters to the actual effect upon researchers who are to be influenced by the priority set. The laissez-faire nature of the researchers makes the specificity of this communications bridge vitally important. The next communications bridge crosses from the results achieved by the researchers to the use made by users and others implementating the research itself. The criteria used to establish these last two bridges -- actually the implementation phases from priority-setter-to-researcher and from researcher-to-research recipient -- are both vitally important. In the F&NS, a sharp distinction was made between these two, especially with regard to cost criteria. Properly designed criteria are the necessay guides to communication across each of these bridges, and unless all are crossed, the research-prioritizing scheme has failed.

Third, we need criteria as a basis for analysis in the process. They are the guideposts for the normative measures necessary to make good judgments in setting priorities. They are the evaluative notions of the study. They actually reduce some of the judgment necessary on the part of the priority setters, but mainly they give the priority-setters their judgmental handholds. Also, if we can get systematic additivity and continuity into the research-priorities process, the criteria will form the cornerstone for allowing us to make valuable time-series, comparative evaluations and assessments. Also, the criteria provide the procedural and substantive handholds for making the successive iterations that are so important in these processes.

Fourth, we need criteria since they have a practical procedural value. They direct the nature of the write-ups for the unit nominations in the priority set. Usually many different informers are involved in preparing the write-ups. We are dealing with an increasingly wide range of research subjects covering what is often considered non-comparable subject matter. Now we must try harder to compare them. The burden upon the write-ups is substantial. The problem is doubled when a variety of actors is involved in the decisions about priorities. Also, many other advantages accrue to good research write-ups; the researcher has much of his problem formulation job done, the user can see what the priority areas look like, and, of course, comparative evaluations over time can anticipate how continuing studies must be structured if they are to withstand a comparison. The proof will have to wait, but this author hypothesizes that widespread use of these processes for priority setting and research would provide much greater additivity of research both in conventioanl fields and across traditional subject matter and disciplinary barriers. We have always put high value on getting more additivity of research, but have been frustrated in our efforts. So, indeed, this is a worthy goal.

How Do We Derive the Criteria? One prefatory comment is that we do it by a lot of hard work. This is the thinking part of the exercise since much depends upon it. Moreover, the heavy sequencing nature of these processes allows few chances to reverse ones self and redo the criteria. So this work is up front in the process, and must be thorough.

First, we should rely heavily upon prior work on criteria. A consensus of the key criteria has been evolving. The F&NS concentrated upon probability of success and expected impact on world hunger. It also considered cost of doing the research and cost of implementing it, especially in other countries. Also, certain specialized criteria were used. Most studies of a more general nature have somewhat this same lineup of criteria. The more specific studies have tended to put more emphasis on specific cost-benefit ratios in allocating a fixed research budget. Each type of study will need to look carefully for the specific criteria most useful to that study. Fortunately experiences with these processes are such that reasonable review of studies similar to the one being contemplated will yield useful insights about criteria which others have used.

Fishel for his purposes looked hard for universality in priority concepts. His three general criteria are useful as a guide for general studies as follows:

"As a starting point, three fundamental criteria of research selection -- relevance, feasibility and performance -- are assumed to be universally applicable to research priorities and, consequently, form the base for considering characteristics:

. . . .

"Type I. Relevance

"Importance of the problem, relative to particular socio-economic clientele and subject to capacity of clientele to implement the research products.

"Type II. Technological Feasibility

"Susceptibility of the problem to research within the scope of existing state of the arts and research capabilities. There are two main aspects of this criterion:

"A. Knowledge Base: sufficiency or insufficiency of knowledge in specific technical areas.

"B. Researchability: adequacy or inadequacy of research capabilities -- i.e., the base of skilled personnel and research techniques -- for research, with some reasonable degree of likelihood, to produce significant results.

"Type III. Performer Capability

"Basically, how the research is to be done, or the capacity of the alternative research organizations to carry on the research within the scope of their missions. There are also two major parts to this criterion:

"A. Plan of Research: adequacy or inadequacy of the research plan for solving the problem.

"B. Resources: adequacy of a mix of available resources relevant to the priority research.

"These three criteria are inherent in all priority sets regardless of level of research aggregation or organization. The differences that may be noted in how these criteria are reflected in priority sets arise from variation in attributes common to all priority sets. It is now apparent that if the criteria are universally applicable, responsiveness of research to priority sets can be explained in terms of one or more of these three criteria. Hence, the specific reasons for responsiveness are to be found in the particular nature of the attributes in each case."[19]

Second, the component parts of the unit nominations must be identified and defined so they will withstand quantitative measurements. This is a most difficult and important procedure. Researchers often take on faith many of the reasons for undertaking their research as well as expected impact of it. They resist specific measures of impact, expectations, costs, and other things which rate much lower in their priority scale than do their hypotheses. So, both component definitions and measurement methods must be explicit and designed to discipline both informers and decision makers. Also, the decision must be realistic and practical enough ultimately to convince others such as Congress, budget offices and final users. The F&NS came down hard on trying to get the scientists to measure expected impacts in relevant ways for different research areas including such as increased yields, reduced resource loss, improved nutrition, reduced death rates, savings in inputs in such as water or fertilizer, intensity of adoption in the United States and/or elsewhere, geographic impacts specifically for different types of research, impact upon follow-up research for some of the more basic ideas, utilization of prior research, and so on. Also, the probability of solution was pushed hard. What are the probable odds of actually solving the research problem? When? What would that mean in terms of research funds to get the job done? What about the available research talent? Will you have to wait until some are trained? Will your program lure needed scientists from other areas. Is it something that can be fitted into existing institutional arrangements for such research? Can U.S. and foreign scientists cooperate? These and many specific component measurements and identification ideas were used to make the general criteria come alive for guidance and discipline. The ability of the study-team scientists to handle this array of evalations was quite encouraging.

These detailed component ideas must be written in a form that makes them clear to the formulators of the priority-setting exercise and to each who is to use them later. There is no substitute for their being explicit and written.

Third, the criteria must be tailored to the particular exercise, especially for unique goals of the research. Care must be used to avoid being misled by the prior work. The generality classification by Fishel above is helpful but it can be dangerous. If the research tends to be more basic, the criteria must be more general. If one is looking to break some barrier to scientific progress generally, the criteria are much different than if one is building a well-conceived additional step on a rapidly-moving, and well-directed area of science. In fact, a special problem can exist in this example: how do you set the criteria on which to decide the question of whether higher priority is to be put into an already proven area or whether the higher priority goes to opening up a new area of work? This was a most troublesome problem in the F&NS. Complementarity of research efforts may be very important in some studies, especially in a small research establishment which must have some diversity for reasons such as might exist in a small state agricultural experiment station, but which cannot aford wide diversity. Also, joint uses can be important. Congress made clear to framers of the F&NS that research with expected impact in both the U.S. and developing countries would be higher priority in the eyes of Congress than that with expected impact only in developing countries. The point is that each priority-setting exercise probably should have its own criteria, or at least its own design of criteria specificity.

Fourth, criteria must be checked for their interrelatedness. Several measures were necessary in the F&NS to establish the interrelatedness of impact and probability. The two were interrelated but for most purposes the interrelationships did not invalidate the study. This, however, is a problem. The literature is helpful on this issue and good statistical counsel is advised.

Fifth, criteria cannot necessarily be established in detail for all aspects of the exercise. Certainly detailed quantitative measurements cannot. So it is important to know when you are giving guidance to your decision judges and when you are telling them they will have to go on their own. Also, the point on interrelatedness is involved here. If we could specify quantitative measurements in-depth for each criteria, we would have no need for the decision-making judges. All we would need is a computer, or possibly accountants with calculators. Let use illustrate the point from a court of law. Our laws do not cover all crimes; if so, the cop or the bailiff could check the list, and then sentence or free the suspect. We have judges to handle the subtle interrelationships. We take advantage of their compassion, their precedents with prior experience and results, their willingness to see the potential for rehabilitation, their unique capacity to integrate knowledge from this case and others, their humanity, and their knowledge of existing jurisprudence. So it is with the priority-setting notion. Criteria are a guide; some are related at least in a way known to the statistician and some are related only in the mind of the decision maker. Remember, judgment is the precious resource we are trying to utilize.

Sixth, once all the good work is done in establishing the criteria, the next hard job is in compromising these criteria against the processes. The use of criteria is expensive. The study has limited resouces and people. The result is often to utilize the component breakdowns and measurements, especially for the informer in preparing the material for the judges. But the judges have this compacted and analyzed and are fed the detail only in the iterative decision-making process. Thus, they usually do their prioritizing on a relatively small number of criteria. Good staff work can increase the ability of the study to play to their comparative advantage--judgement.

Deciding Upon What to Consent The general problem discussion at the beginning of this paper was designed to help narrow the overall "what" issue. But more needs to be done. Fishel in his discussion about priority sets has given great help on this issue; we need not repeat him. His emphasis upon the importance of priority-set design in the implementation phase is encouraging. Thus, the argument as to whether priority-set determination is more important than priority-set implementation may be moot. Certainly to this author, the priority-set determination is more important in its own right than some people argue. Actually in the Fishel argument, one can conclude that priority-determination is key to implementation. But, let us drop that and discuss the issue of deciding upon what goes into the priority set or put another way, decide how to define those things upon which the actors hope to consent.

Factors determining the priority set are not easy to determine and are tied up in several of the procedures within the total priority-setting exercise, but a few generalizations can be made.

First, the problem definition is vitally important in deciding what should go into the priority set. When we talk problem definition, many nearly turn it off as talking in clichés. This is inappropriate. The purpose of the study, the study setting, the audience intended, and many such factors determine the general parameters of the priority set. So try as we can, we cannot avoid good problem definition.

Second, the priority set is made up of many factors and if the procedures have been wrel designed as discussed above, the priority set is by this point fairly well prescribed. Yet, decisions must be made and finalized since a time comes when the priority set must be fixed; otherwise you can never get it to hold still while the decisionmakers prioritize it. A check must be made before the actual rankings start to be sure that all the procedural steps have been reflected in the definition of the priority set -- resource constraints, time periods, criteria feedback, how the priority data fit with other data in the final data formulation or other use, and anything else that is appropriate. The priority set is affected by many things but a time arrives at which the priority set must be defined.

Third, the actor input is important in defining the priority set. Do the study designers do it, or do the informers, or the users, or the decisionmakers? This will vary, but agreement must be reached about where this responsibility resides. The questions of when to bring in an actor, which actor to bring in and what weight to give to each all impact upon how the priority set is developed. The most important issue here lies in the degrees of freedom the actors have in the exercise and how much is imposed from outside. Each study will differ but this question must be answered.

Fourth, comparable size of units within the priority set are terribly important. There is a great tendency in priority setting to use packaging expertise to put two or more unit nominations together to avoid having to choose among them. Putting the priority set in units capable of being comparable tends to avoid this urge to repackage. Packaging is especially important with regard to size. Again, definition rigor is so important -- if actors can circumvent the defined priority set units, the study will fail even at this late hour of the home stretch.

Fifth, future uses of priority sets must be considered along with the current use. A little forethought will make for much more comparability with other current and anticipated priority sets. This can be done with only marginal problems for the current priority-setting exercise and in most cases will probably improve upon it as well.

Fishel has given much thought to the nature of the characteristics of priority sets and his list is worthy of consideration:

> "I identify eight principal characteristics of priority sets, as follows:
>
> Environment -- basically the political, social, economic factors related to and impacting on relevance.
>
> Source -- type and nature of group responsible for the priority set as discussed earlier.
>
> "Purpose -- how priority set is intended to impact on the research in terms of

product or performance.

"Objectives -- desired impact on clientele or social group contained in priority set items.

"Structure -- how the priority items are presented in terms of the level of aggregation or specificity of research identified.

"Form -- nature of the order in the priority set.

"Process -- mechanism or system for implementing identified research.

"Time Relevance -- period of time to which priority set is applicable.

"Another characteristic that might be added is the selection criterion, the explicit or implicit values and value weights indicating basis of choice inherent in a priority set. I leave this out because the product of the criterion is largely captured in the other attributes and the primary interest of the specifics is on the development side of the topic, whereas the interest here is on the implementation side...."[20]

IMPLICATIONS

The implications from this paper are of two types: (1) quite general ones for the whole system, and (2) specific ones for the actors involved.

Implications for the Whole Research System. First, the focus of this paper, essentially from a process point of view clarifies the question raised by the total OTA exercise: "Is tnere a real problem"? The rigor of this type of process emphasis may tend to over-identify and probably exaggerate the problems we find in a more *laissez-faire* system. However, such an exaggerated look can be useful in establishing whether or not a problem actually exists. From the process point of view, one must be convinced that a problem does in fact exist. Moreover, the operational issue is one of how to get hold of that problem. Hopefully, the approach of this paper has operational promise. The paper holds that the research system itself is being bogged down with many other policies, political and strategic matters, and their problems. The research system needs a chance to stand more on its own in making some priority judgments, and this approach has much power for improving consensus-making about these judgment questions within the system.

Second, and more important, this rigorous planning-process approach goes a long way in arguing for a fairly open, freely operating research system. To many experts, the highly legislated national planning system is forecasting its own doom. This makes the approach of this paper appealing. Almost paradoxically, the research system itself must have a firm discipline if it is to be freed up and given the autonomy it seeks. A pervasive application of many of the concepts of this paper could give society some assurance that the system has its own discipline.

Third, the system is doing itself much harm by internal strife. This attracts misery from other households in society including the Congress. A need exists for finding mutuality both within the system and between the system and those who have a legitimate interest in the system. The concepts of these processes foster a basis for goodwill, better information, improved communication, a manageable agenda, and enlightened compromise and consensus. The areas of mutuality need to be identified and nurtured; the process approach does that. That is the *raison d'etre* of this approach.

Fourth, highly related to the third point above, great need exists for identifying the roles of the many actors and institutions involved. Actors and institutions within the system have comparative advantages that appear to be underutilized. The roles of various actors within the system and those outside need to be inventoried, clarified, and assigned. The basis for interaction by the various actors within these "new processes" can then be positive. The process could be operational in ways such as workshops among actors, priority-setting exercises among actors, and a continuity of regular assessments and evaluations which could be anticipated by all actors.

Fifth, the need for continuity in planning and evaluation within the system seems obvious. It is lacking. This process has a strong basis for additivity through time, and an alternative approach to give that is not obvious at the moment.

Sixth, issues about resources for research are of great concern to many in and out of the system. The processes emphasized here assure better allocation of scarce resources. But they also sort among the three budget issues: (a) size of the budget for research, (b) priorities for allocating the budget for agricultural research, and (c) the interaction between the two. In this way budget decision-making can deal effectively with each of the three budget issues.

Seventh, research priority-setting processes themselves need improvement. The concepts of these "new processes" are more convincing in their own right for that purpose than alternatives in sight.

Implications for Specific Actors. First, users could make some use of these processes directly; however, their insistence on the use of such processes by scientists and research administrators would do users more good. Some use of the processes by the user groups themselves might help communication with the scientific community. A scientifically-based consensus on research priorities by users would certainly be more convincing to research managers and Congress than are current user inputs. Such a positive approach would effectively replace what now too often appears as simply uncoordinated and uninformed criticism. If users do their own priority setting, they would be well advised to do it in a professional way because the specificity of the approach not only makes it more powerful but also more open and vulnerable if not well done.

Second, society representatives should make it clear that they expect scientists, managers and possibly users to be able to stand behind their research priorities, however derived. Without a better alternative process, they may want to expect more use of the concepts of this paper. They should consider sponsorship of some application of these approaches if they want the processes to move forward and retain their objectivity. But, they should use it only on that part of the "research problem" on which it fits. Also they should see that it is well done.

Third, research managers need to consider much wider use of the concepts of these processes. They can visualize loss of power in the process, but that is probably true only relative to their perception of their power in the current processes, not relative to their real power the processes. In the longer-run, they must take leadership for bringing the scientists into some more accountable and pluralistic system. This need not be a least/worst solution; enough of the processes are promising to offer hope.

Fourth, scientists should consider some expansion in the use of the processes. The concepts can sharpen their own priority setting with low costs. More important, this could involve other actors in their priority process and yet retain substantial control in the use made of the priorities. Working in mutual goodwill with other actors through the processes holds much more promise for the scientists' self interests than using the alternatives. Scientists, in defense of their own freedom, should point out, however, that consensus is not always what is needed in a progressive research program.

Fifth, others should evaluate the implications of the increased use of these concepts. Private research agencies have been using them and may find joint ventures with other actors to be mutually advantageous. Private consultants have a special role in that many organizations cannot afford to develop the specialized expertise. Also, consultants may add a much-needed level of objectivity. International agencies are users of these approaches and more cooperation with other international organizations as well as with other domestic organizations may be profitable. The National Academy of Sciences has used these processes but at an intensity which is probably much below optimum. The same is probably true for most Federal and State research organizations.

Some Cautions First, these processes are still evolving and have not proved themselves in many situations. They do have costs and they require specialized expertise. They probably have a rather high threshhold cost before one gets the processes sophisticated enough to be better than existing methods. More important, they cannot replace many techniques well established in this country for consensus making. For example, they have not replaced political debates; they cannot surround problems that the mind cannot comprehend; they cannot create judgment; and they cannot substitute for peer accountability or scientific objectivity.

Second, we must avoid pushing these processes as a formula for setting priorities. The concepts are valuable, but the processes constitute guides, not a formula. The risk of this paper is that it might overstimulate those who too often take the mechanical approach to such problems. Then they might attempt to substitute these processes for judgment. Actually, this paper aims not only to defend the use of judgment, but also to encourage a wider use of it -- albeit in a more rigorous and disciplined way.

Third, consensus-making is not the only characteristic of these processes, but it is an important one. We do not always want a consensus. Scientists make convincing arguments that the life blood of their creativity and objectivity lies in their diversity and controversy. These processes, with or without consensus, have limits. They cannot handle well the special need such as the breakthrough effort, the catalytic effort, or the identification of a latent limitation to a discovery. They have not handled the interdependence among criteria well. The sequence problem in research, especially agricultural research, comes hard and they have not handled it well. Their consensus making qualities do not create, neither do they guarantee objectivity. Thus, as important as consensus-making may become as a public concept, it must not be allowed to destroy the very private nature of research.

Footnotes

1. This rather loose term is used for a reason and is developed more thoroughly on page 19.

2. Fishel, Walter L., Responsiveness of The Public Food and Agricultural Research System to Identified Priorities,"(Unpublished paper) December 1980.

3. Knutson, Ronald D., Don Paarlberg and Alex McCalla, "Setting Food and Agricultural Research Priorities: How Research Decisions are Really Made," Office of Technology Assessment, December 1980.

4. Castle, Emery N. "Agricultural Education and Research: Academic Crown Jewels or Country Cousin?", Kellogg Foundation Lecture, NASULGC, November 18, 1980.

5. Arndt, Thomas M. and Vernon Ruttan, "Resource Allocation and Productivity in National and International Agricultural Research," Research Seminar, Agricultural Development Council, Inc., September 1975 and subsequent publications.

6. Paarlberg, Don, "The Farm Policy Agenda," Increasing Understanding of Public Problems and Policies, Farm Foundation, Chicago (1975), and "The Food and Agricultural Research Agenda," Agricultural Outlook Conference, USDA, Washington, D.C. November 19, 1980.

7. Kramer, John, "Agriculture's Role in Government Decisions," Task Force Paper for National Farm Summit, Texas A&M University, December 1978.

8. Castle, op. cit. and prior writings.

9. A very good survey of efforts to that date was compiled by Baker, N. R. and W. H. Pound, "R and D Project Selection: Where We Stand," IEEE Transactions on Engineering Management, Vol. EM-11, pp. 124-134, Deember 1964. Other surveys cited in the bibliography of that survey are also useful. The survey by Baker and Pound was updated by Cetron, Marvin I., Joseph Martino, and Lewis Roepecke, "The Selection of R&D Program Content-Survey of Quantitative Methods," IEEE Transaction on Engineering Management, Vol. EM-14, No. 1, March 1967.

10. Shumway, C. Richard, "Allocation of Scarce Resources to Agricultural Research: Review of Methodology," American Journal of Agricultural Economics, Vol. 55, No. 4, Part I, November 1973. Also, see Shumway, C. R., "Models and Methods Used to Allocate Resources in Agriculture Research: A Critical Review," Conference on Resource Allocation and Productivity in International Agricultural Research, Airlie House, January 26-29, 1975.

11. Ibid. AJAE, pp. 557-558.

12. See Ibid, pp. 557-565 for details.

13. Fishel, (Unpublished paper) December 1980.

14. Ibid, pp. 23-24.

15. National Academy of Sciences, World Food and Nutrition Study, Washington, D.C. (1977).

16. Brady, N. C., "Criteria for Establishing Research Priorities and Selecting Research Priorities." Talk presented at the Workshop on Methods Used to Allocate Resources in Applied Agricultural Research in Latin America, November 26-29, 1974, Cali, Columbia.

17. Lowe, S. F., "How to Reach a Real Consensus," The Financial Post, February 15, 1975.

18. The term "public representative" was avoided since it is too inclusive and includes many other actors, especially scientists and managers.

19. Fishel, (Unpublished paper) December 1980.

20. Ibid, p. 15.